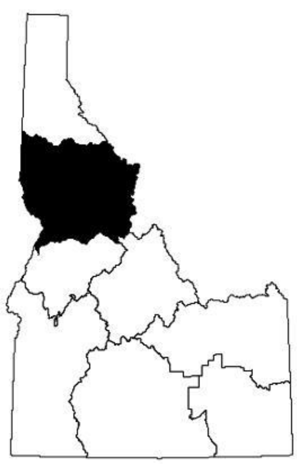
FISHERY MANAGEMENT INVESTIGATIONS

IDAHO DEPARTMENT OF FISH AND GAME
FISHERY MANAGEMENT ANNUAL REPORT

Ed Schriever, Director



CLEARWATER REGION
2015

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ANGLER EXPLOITATION OF RAINBOW TROUT IN REGIONAL PONDS

ABSTRACT

Angler exploitation rates of hatchery catchable Rainbow Trout *Oncorhynchus mykiss* were evaluated in Campbell's and Palouse River Dredge ponds during 2015. In Campbell's Pond, the angler total use of stocked Rainbow Trout (fish harvested plus fish released) was estimated to be 37.1%, close to the IDFG management goal of a 40%. As such, no changes are suggested for future stockings. This estimated total use rate was substantially different than the 86.5% calculated for a creel survey conducted on Campbell's Pond in 2014. This large difference in angler exploitation rates between the two survey methods was also noted in 2012 at eight regional reservoirs where both methods were used. These differences may have been caused by factors such as bias from the use of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. In the Palouse River Dredge Pond, the angler total use was 40.6%, meeting the IDFG management goal of a 40%. This was much higher than the 20.4% angler use rate calculated in 2011. As such, no changes are suggested for future stockings.

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INTRODUCTION

An important component of our lowland lake fisheries are catchable-sized (203 - 254 mm) Rainbow Trout *Oncorhynchus mykiss* stocked by our hatcheries. As part of the lowland lake program, hatchery trout provide an easily accessible harvest opportunity, create an "instant" fishery when stocked, and meet very high angler demand in areas where natural reproduction is unable to match the harvest demand. The goals of our catchable, Rainbow Trout stocking program is to maintain a minimum catch rate of 0.5 fish/hour in stocked lakes and >40% "total use" (fish harvested and released; IDFG 2013). Evaluating the return to creel rates, especially in new fishing waters, provides information to assist in the management of these fisheries for angling and harvest opportunities.

OBJECTIVE

1. Evaluate angler exploitation rates of hatchery catchable sized Rainbow Trout in select regional ponds.

STUDY AREA

Angler exploitation studies of catchable size Rainbow Trout were conducted on two regional ponds. The Palouse River Dredge Pond is east of Laird Park near the confluence of Strychnine Creek and the Palouse River (Figure 1). This pond is approximately 0.5 ha in size. Campbell's Pond is located approximately 10 km northwest of Pierce, Idaho (
Figure 1). It is approximately 4.1 ha is size. Facilities at the pond include camping, boat ramp, picnic tables, ADA accessible fishing dock, and toilet.

METHODS

Angler exploitation surveys were conducted on hatchery catchable sized Rainbow Trout stocked in Campbell's and Palouse River Dredge ponds. Rainbow Trout were tagged at IDFG's Clearwater Fish Hatchery. Fish were tagged with t-bar anchor tags (Hallprint tags model FD-94). Tagging data was submitted to our Nampa Research office and uploaded to the IDFG "Tag You're It" database. Tagging, data entry, and analysis was conducted using the methodology described in Meyer et al. (2010). Rainbow Trout stocked into Campbell's Pond were tagged on May 6, 2015 (n = 104). Rainbow Trout stocked into the Palouse River Dredge Pond were tagged on May 6, 2015 (n = 50).

RESULTS

Campbell's Pond

This was the first time angler exploitation has been evaluated in Campbell's Pond. The angler exploitation (fish harvested) rate through 365 days at large was 27.3% (Table 1). The angler total use (fish harvested plus fish released) rate through 365 days at large was 37.1% (Table 1).

Palouse River Dredge Pond

The angler exploitation (fish harvested) rate through 365 days at large was 28.4% (Table 1). The angler total use (fish harvested plus fish released) rate through 365 days at large was 40.6% (Table 1). This was higher than the 20.4% angler exploitation and total use rates estimated in 2011.

DISCUSSION

Campbell's Pond

Angler exploitation of hatchery Rainbow Trout was evaluated in Campbell's Pond to determine the effectiveness of our stocking program and for comparison with data collected during a creel survey conducted in 2013. The angler total use (fish harvested plus fish released) rate was estimated to be 37.1%, above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). Additionally, this estimate was close to the average of 36.2% calculated for regional reservoirs in 2012 (Hand et al. 2016a), and the IDFG management goal of a 40% total use rate for hatchery catchable Rainbow Trout (IDFG 2013). Tag return data shows that all of the returns occurred by July 17th (Figure 2). This is to be expected since most of the effort in our regional reservoirs occurs from May - August each year (Hand et al. 2017). This suggests that few, if any, of these fish survive through the summer to be available for fall fishing. Based on this information, no changes are suggested for future stockings.

We also compared the estimated angler exploitation rates from the "Tag You're It" program (Meyer et al. 2009) to a creel survey conducted on Campbell's Pond in 2013. The estimated total use rate for the creel survey was 86.5% (Hand et al. 2016b), compared to the 37.1% estimated by the "Tag You're It" program. This large difference in angler exploitation rates between the two survey methods was also noted in 2012 at eight regional reservoirs where both methods were used. In the 2012 surveys, differences in estimated exploitation rates between the two methods ranged from 4.3 - 50.0%, with an average of 20.3% (Hand et al. 2017). These differences may have been caused by factors such as bias from the use of angler report cards, a lower reporting rate of tags than expected, or an overestimation of effort or harvest rates in the creel survey. A more detailed analysis of the differences in exploitation rates between these two survey methods will be conducted in a separate report.

Palouse River Dredge Pond

Angler exploitation of hatchery Rainbow Trout was evaluated in the Palouse River Dredge Pond to determine the effectiveness of our stocking program, and for comparison with data collected during a previous angler exploitation survey conducted in 2011. In 2011, the angler exploitation rate was estimated to be 20.4%. The angler total use rate was also 20.4% because no anglers reported releasing any fish. This was much lower than the angler total use of 40.6% estimated for 2015. The 40.6% total use rate in 2015 was above the statewide average rate of 28% calculated for hatchery Rainbow Trout in Idaho lakes and reservoirs from 2011 - 2012 (Koenig 2012; Cassinelli 2014). Additionally, this estimate was above the average of 36.2% calculated for regional reservoirs in 2012 (Hand et al. 2017), met the IDFG management goal of a 40% total use rate for hatchery catchable Rainbow Trout (IDFG 2013). Because stocking of the

Palouse River Dredge Ponds first occurred in 2011, we speculate that the increase in angler exploitation from 2011 to 2015 was related to increased awareness of this new stocking location.

Tag return data (Figure 3) shows that all of the returns occurred by July 28th. This is to be expected since most of the effort in our regional reservoirs occurs from May - August each year (Hand et al. 2017). This suggests that either few of these fish survive through the summer to be available for fall fishing, or that there is little (or no) effort after the summer months. At this time, no changes are suggested for future stockings.

MANAGEMENT RECOMMENDATIONS

1. Continue to improve public awareness of regional small pond stockings through the use of regional fishing trailer, media releases, and postings at local businesses.

2. Re-evaluate angler exploitation rates of small pond stockings every 3-5 years to monitor the effectiveness of this program.

Table 1. Angler exploitation rates (estimated harvest), and total use (fish harvested and fish released) for small ponds in the Clearwater Region, Idaho, 2015, through 365 days at large.

Water body	Tagging date	Tags released	Disposition: Harvested	Disposition: Harvested b/c tagged	Disposition: Released	Adjusted exploitation: Estimate	Adjusted exploitation: 90% C.I.	Adjusted total use: Estimate	Adjusted total use: 90% C.I.
Campbell's Pond	06-May-15	104	14	2	3	27.3%	13.3%	37.1%	15.6%
Palouse River Dredge Pond	06-May-15	50	7	1	2	28.4%	18.8%	40.6%	22.1%

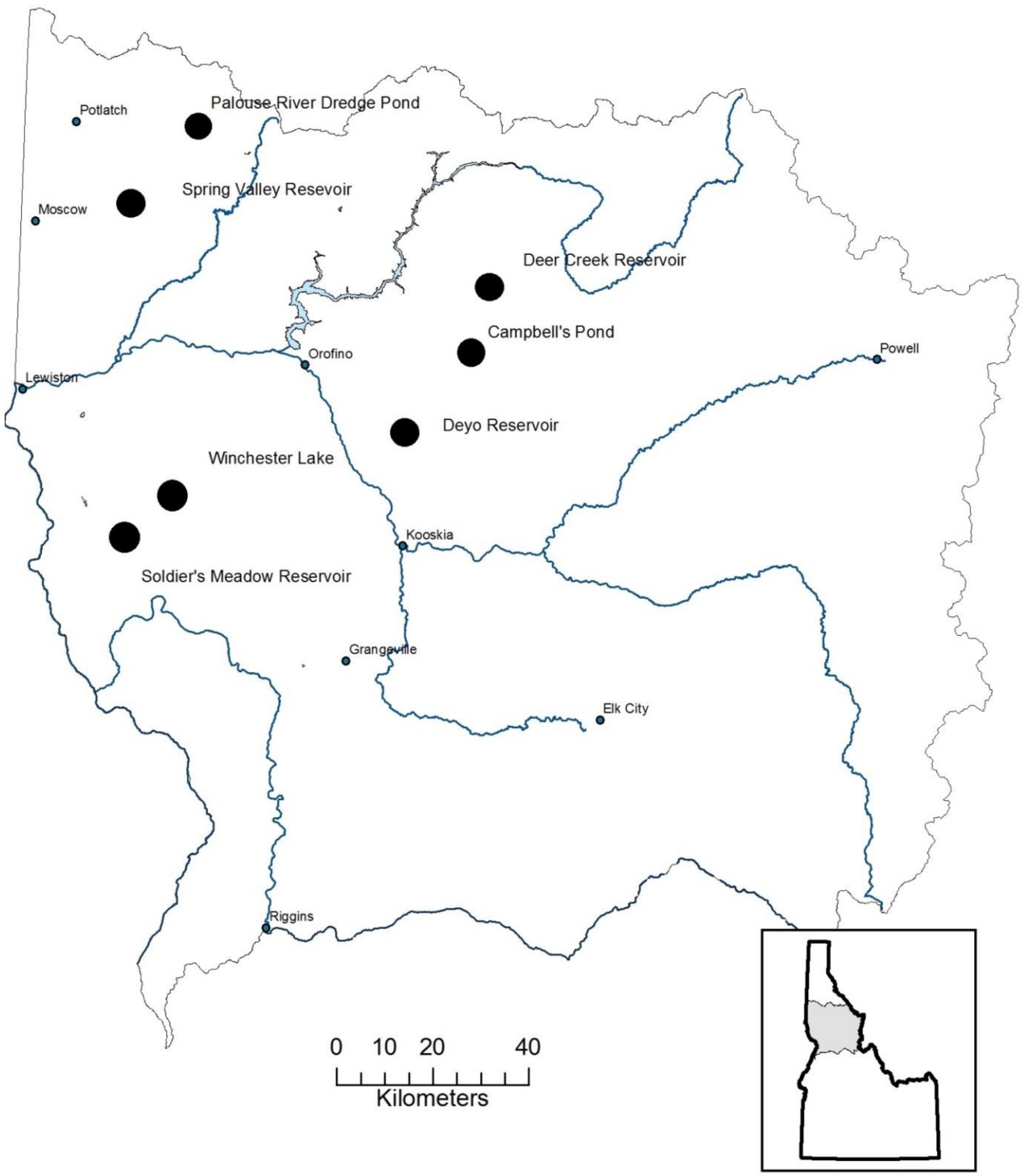

Figure 1. Map showing locations of reservoirs and ponds surveyed in the Clearwater Region, Idaho, during 2015.

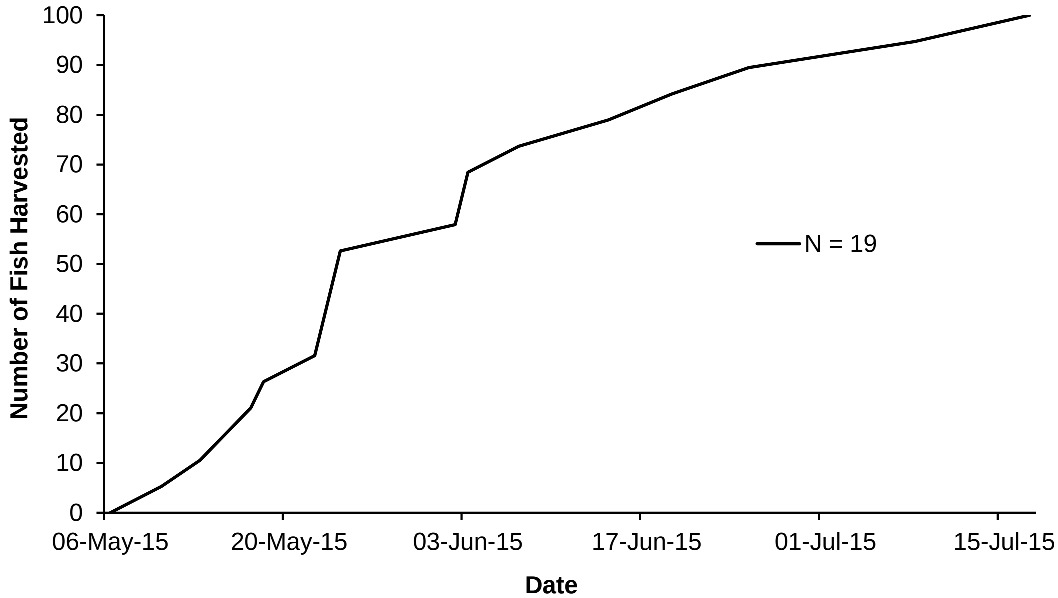

Figure 2. Cumulative number of tagged hatchery catchable Rainbow Trout caught from Campbell's Pond, Idaho, from May 6, 2015 stocking, based on angler exploitation surveys (104 fish tagged).

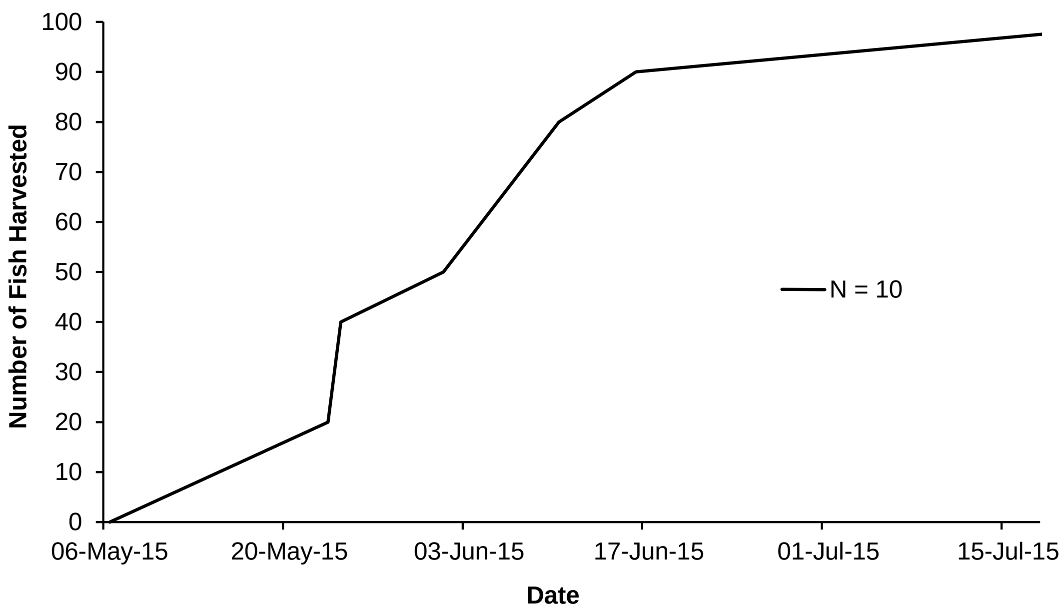

Figure 3. Cumulative number of tagged hatchery catchable Rainbow Trout caught from Palouse River Dredge Pond, Idaho, from May 6, 2015 stocking, based on angler exploitation surveys (50 fish tagged).

DEER CREEK RESERVOIR: MONITORING THE EFFECTIVENESS OF TIGER TROUT FOR CONTROLLING GOLDEN SHINERS

ABSTRACT

Fingerling tiger trout (Brown Trout *Salmo trutta* X Brook Trout *Salvelinus fontinalis)* were stocked in Deer Creek Reservoir in the spring of 2014 and 2015 for the purpose of controlling an overabundant Golden Shiner *Notemigonus crysoleucas* population through predation. No tiger trout were collected by gill nets during 2015. The lack of success in sampling tiger trout raised questions about the efficacy of stocking these fish as fingerling. We speculate that the failure of the fingerling tiger trout stockings were related to lack of adequate food resources (zooplankton) prior to them reaching a picivorous size. Stomach samples of Rainbow Trout *Oncorhynchus mykiss* and Brook Trout collected in previous surveys indicated that these fish begin preying upon Golden Shiners at lengths >250 mm. Based on these findings, we recommend stocking all trout species at sizes >250 mm in the future. Additionally, we recommend conducting future sampling of Golden Shiners during summer months (June - August) to allow for comparison with previous data.

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INTRODUCTION

Deer Creek Reservoir (DCR) is the most remote of the Clearwater Region's lowland reservoirs, located approximately 140 and 185 km from the region's two largest population centers of Lewiston (pop. 32,119) and Moscow, ID (pop. 24,080), respectively. Based on creel surveys, DCR accounted for an estimated 14,709 h of angler effort in 2005 and 5,254 h in 2012 (Hand et al. 2017). An economic survey conducted in 2011 estimated anglers took 1,175 trips to fish DCR and spent $75,707 in doing so (IDFG, unpublished data) and was one of our lesser-used reservoirs. However, DCR is an important part of the lowland lake program as it provides a location for trout harvest in an area where all stream fishing is under restrictive harvest regulations (two trout per day). It also adds diversity to our fisheries program as it is the only lowland lake managed for only trout. Deer Creek Reservoir has been stocked with Rainbow Trout *Oncorhynchus mykiss*, Westslope Cutthroat Trout O. clarkii lewisi, and Brook Trout *Salvelinus fontinalus*, and fingerling tiger trout (TT) (Brown Trout *Salmo trutta* X Brook Trout *Salvelinus fontinalis).* No warm-water game fish species are present.

In 2013, we determined that DCR had an overabundance of Golden Shiner *Notemigonus crysoleucas*, a non-native species. Deer Creek Reservoir was previously renovated with rotenone in 2006 and 2010 to remove introduced Golden Shiners (Hand 2006; Hand et. al. 2010). It is unclear on how Golden Shiner got into DCR, but later surveys found them distributed in ponds and streams throughout the area. The attempts to eradicate Golden Shiners from DCR were based on two thoughts: (1) Golden Shiner is an effective planktivore and would compete with trout for food resources, and (2) Golden Shiner might spread downstream into Dworshak Reservoir which supports an important kokanee fishery that has been found to generates over four million dollars annually in expenditures for the surrounding communities (IDFG, unpublished data).

Golden shiner have been sampled at 3- or 4- year intervals since DCR was constructed during 2003. Golden Shiners were first detected in 2006, and the reservoir was chemically treated with rotenone the same year. Golden Shiner was observed again in 2010 and a treated again (Hand et al. 2013). Electrofishing surveys conducted in 2012 on DCR did not yield any shiner species (Hand et. al. 2016b); however, shiner was observed at small lengths and low numbers in the reservoir while completing other surveys. The Golden Shiner population in DCR may have a population growth rate which requires 3 - 4 years to reach a large enough population at adequate size to be detectable.

In an attempt to control Golden Shiner, IDFG stocked fingerling TT in DCR in the spring of 2014. Tiger trout have been reported to be a more effective predator than the parent species (Sheerer et. al. 1987). Hopes were that the TT could effectively control shiner abundance, improve the food base for the other trout that depend on zooplankton, and provide a new fishing opportunity.

A study was initiated in 2014 to monitor the Golden Shiner population and the impacts of stocked fingerling TT on these fish. Zooplankton sampling revealed a substantial decline in zooplankton length and abundance compared to previous data when Golden Shiners were absent. It was speculated that the decline in zooplankton abundance may have been a primary reason why only one TT was collected in 2014, and would likely result in future decreased growth and survival of trout dependent on this food source (Galbraith 1975; Tabor et al. 1996; Wang 1996). Due to this new information, and potential changes needed to improve this fishery, we repeated our fish sampling in 2015 to further evaluate the TT stockings.

OBJECTIVES

1. Monitor the success of TT being stocked and their influence on the size structure and abundance of Golden Shiners.

STUDY AREA

Deer Creek Reservoir is located in Clearwater County, Idaho, 21 km north of the town of Pierce, Idaho (

Figure 1). It is a 47-ha reservoir located at an elevation of 1,006 meters. It has a maximum depth of 11 m, and a maximum volume of 759 acre-ft. Completed in 2003, it is the second newest reservoir in the state of Idaho. It was created by damming Deer Creek, a tributary of Reeds Creek that flows into Dworshak Reservoir. The reservoir and watershed is owned by Potlatch Corporation. Idaho Department of Fish and Game leases the reservoir property from Potlatch Corporation. Today, the reservoir is used extensively by boaters and anglers and provides unique trout fishing opportunities.

METHODS

A gill net survey was conducted on May 5 - 6, 2015 to sample the fishery in DCR. Fishes were sampled using four overnight gill net sets (Hand et al. 2012). Two floating style and two sinking style monofilament gill nets 36-m long and 1.8-m high were used. The nets are divided into six equal size panels with bar mesh sizes of 10.0, 12.5, 18.5, 25.0, 33.0, and 38.0 mm. Monofilament diameter ranged from 0.15 to 0.20 mm. Nets were placed in locations that were free of woody debris to prevent snagging. All sampled Golden Shiner were measured for total length and recorded into 10-mm length groups. Sampled trout species were measured to the nearest millimeter. All trout were dissected to examine stomach contents for presence of Golden Shiner.

RESULTS

Gill net surveys collected Golden Shiner, Rainbow Trout, Cutthroat Trout, and Brook Trout. Golden Shiners (*n* = 118) ranged in length from 80 - 162 mm and averaged 105 mm (Figure 4). This average length was larger than the 95 mm average for Golden Shiner collected by gill nets in 2014. Rainbow Trout (*n* = 48) ranged in length from 209 - 365 mm and averaged 294 mm (Figure 5). Brook Trout (n = 32) ranged in length from 214 - 352 mm and averaged 270 mm (Figure 6). One Westslope Cutthroat Trout, 272 mm in length, was collected. None of the trout collected had Golden Shiners present in their stomach contents. This was in contrast to 2014, when Rainbow Trout and Brook Trout >250 mm had Golden Shiners present in stomach contents.

DISCUSSION

This study was prompted by the concern that an overabundance of Golden Shiner in DCR could potentially reduce the primary food source (zooplankton) essential for a reservoir managed as a put and grow trout fishery. Surveys in 2014 confirmed this concern as the zooplankton population in DCR decreased in abundance and size from 2012 to 2014 (Hand et al. 2017). Due to the concerns about the impacts of Golden Shiners, fingerling TT were stocked into DCR beginning in spring 2014 as a predator to control the Golden Shiner population. However, only one TT was collected in 2014 during a reservoir-wide study with multiple gear types, and no TT were collected by gill nets during 2015. The lack of success in sampling TT raised questions about the efficacy of stocking fingerlings. The most likely cause for the failure of the fingerling TT stocking is a lack of adequate food resources (zooplankton) to allow growth to piscivorous sizes.

While the average length and CPUE of Golden Shiner increased from 2014 to 2015, we cannot make a direct comparison with this data since sampling was conducted at different times of year. Future sampling for Golden Shiners should be conducted in the summer (June - August) to allow for comparisons with previous data.

In 2014, Golden Shiner was found in the stomach contents of Rainbow Trout and Brook Trout with lengths greater than 258 and 250 mm, respectively (Hand et al. 2017). This suggests that Rainbow Trout and Brook Trout have the potential of piscivory after reaching a length of 250 - 260 mm, providing the potential for additional predatory pressure on Golden Shiner. Beauchamp (1990) saw a similar response with Rainbow Trout in Lake Washington, Washington where trout that exceeded 250 mm shifted diets to more piscivory.

This information suggests that changes to our management strategy need to be implemented in order to control the Golden Shiner population. The primary change should be to the size of TT stocked. If fingerlings are not surviving long enough to grow to piscivorous size, we should consider stocking them at sizes where they will be large enough to prey upon Golden Shiner immediately after stocking and not have to rely primarily on zooplankton. Additionally, planting larger catchable Rainbow Trout (i.e. magnum size) may also increase predation pressure on Golden Shiner. Thus, based on our findings, we recommend stocking all trout species at sizes greater than 250 mm. Additionally, we recommend that zooplankton monitoring be continued on DCR for the duration of this study and possibly longer to monitor food sources, predator-prey balance, and potential growth rate for trout.

MANAGEMENT RECOMMENDATIONS

1. Sample zooplankton in 2016 to monitor potential changes in size and community structure.
2. Sample fish populations in fall 2016 using electrofishing and gill nets to monitor potential changes in population characteristics.
3. Evaluate growth, condition factor, and diets of all trout species sampled.
4. Stock tiger trout at lengths >250 mm in an effort to increase survival and predation on Golden Shiner.
5. Stock fewer but larger (>300 mm) Rainbow Trout in an effort to reduce competition on zooplankton and to increase the predation pressure on Golden Shiner.

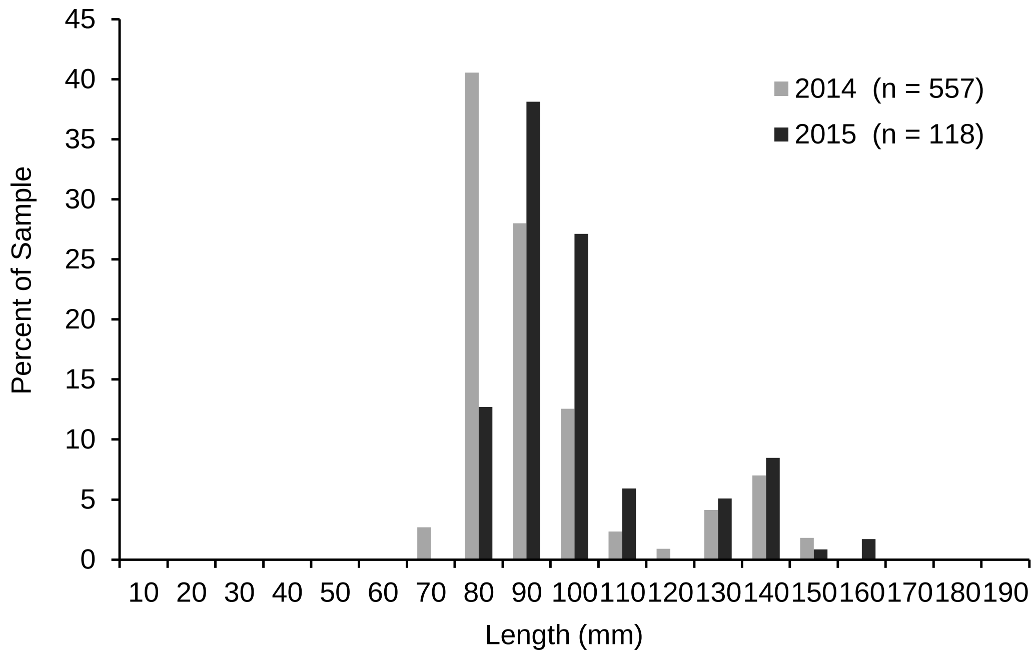

Figure 4. Length-frequency distribution of Golden Shiners collected from gill nets on Deer Creek Reservoir, Idaho, during 2014 and 2015.

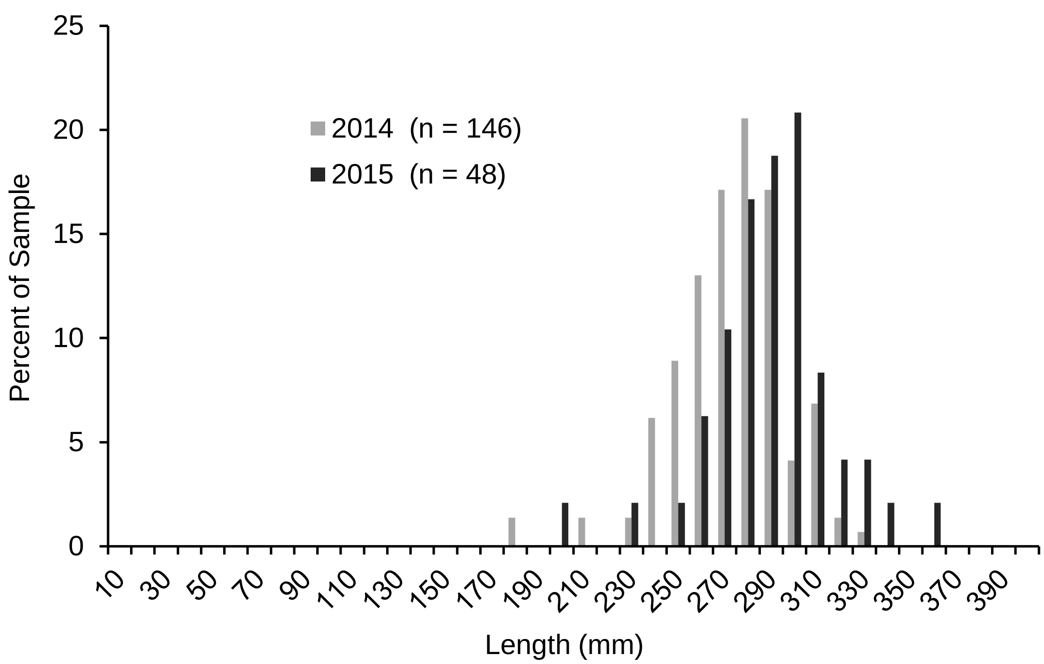

Figure 5. Length-frequency distribution of Rainbow Trout collected from gill nets on Deer Creek Reservoir, Idaho, during 2014 and 2015.

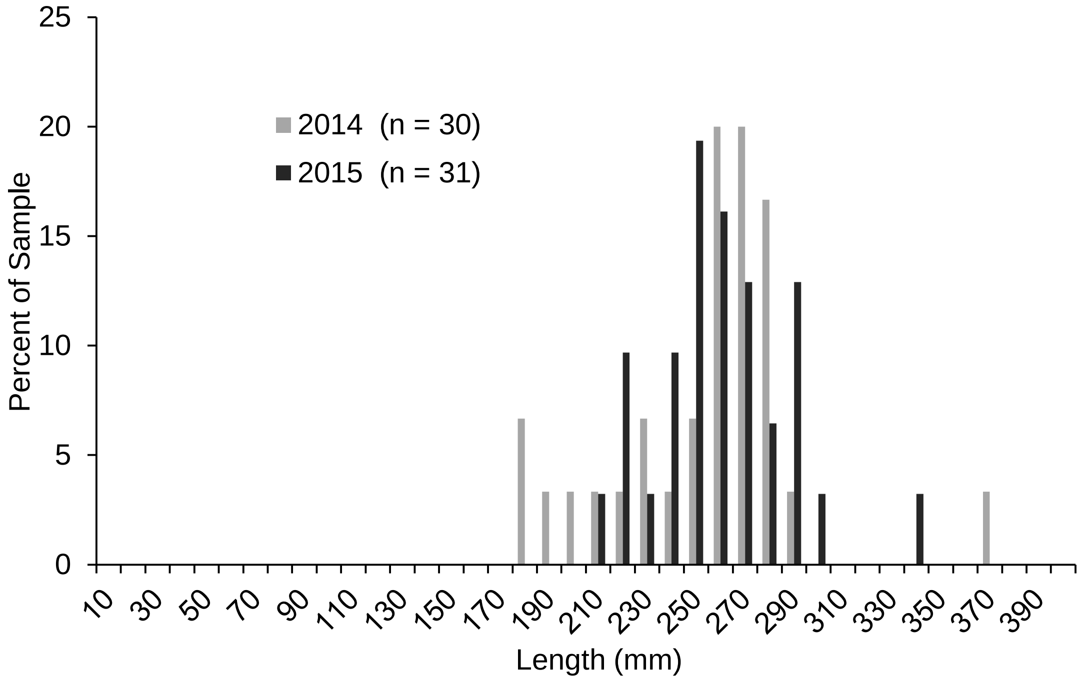

Figure 6. Length-frequency distribution of Brook Trout collected from gill nets on Deer Creek Reservoir, Idaho, during 2014 and 2015.

DEYO RESRVOIR FISHERY EVALUATION

ABSTRACT

The electrofishing survey conducted in 2015 was the second conducted on Deyo Reservoir since its construction. It was conducted to evaluate the fish populations that were stocked in 2012. The CPUE increased from the 2014 survey for Bluegill *Lepomis macrochirus*, but declined for Largemouth Bass *Micropterus salmoides*. As expected, the average length of fish captured increased for both Largemouth Bass and Bluegill. However, due to few fish of quality size captured, the Proportional Size Distribution (PSD) was 31 for Largemouth Bass and 0.1 for Bluegill. Both of these values are below their respective ranges indicating unbalanced populations. Overall, from 2014 to 2015 there was a slight increase in average lengths for both species. The lack of Largemouth Bass >300 mm collected in the survey is concerning, and suggests that harvest is cropping off the larger fish. With approximately 125 Largemouth Bass >300 mm stocked in 2012, even low harvest levels would have a large impact on the population. This could result in reduced predation and recruitment. Thus, we recommend stocking additional Largemouth Bass >300 mm each year over the next few years to improve the size structure of the Largemouth Bass population, and increase predation on Bluegill. Additionally, we recommend implementing a 406-mm minimum size limit with a two fish bag limit to reduce harvest of larger Largemouth Bass, improve their size structure, and increase predation on Bluegill. These measures should help restore the predator:prey balance.

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INTRODUCTION

Idaho's Clearwater Region has a substantial diversity of fishing opportunities. However, many of these fisheries are restrictive in nature: large rivers with anadromous fisheries, high elevation rivers and streams with restrictive rules to protect wild trout populations, and mountain lakes with difficult access. Because of these restrictive regulations and access, the region's lowland lake program has been designed and managed to provide additional fishing and harvest opportunities with easy access. Managing these reservoirs and ponds is a priority for the Clearwater Region fisheries staff.

With this in mind, the Idaho Department of Fish and Game (IDFG), in conjunction with support from local communities, constructed a 22.3-ha reservoir on Schmidt Creek near Weippe, Idaho in 2012. Named Deyo Reservoir, its purpose was to provide a new recreational fishery and an economic boost to the local economy with minimal negative biological impacts (DuPont 2011). The management strategy for this reservoir was to provide a "two-story" fishery, with both cold- and warm-water species. This included stocking sterile catchable size Rainbow Trout *Oncorhynchus mykiss* for a "put-and-take" fishery, and Largemouth Bass (LMB) *Micropterus salmoides* and Bluegill *Lepomis macrochirus* to provide a self-sustaining warm-water fishery. Fish population surveys were conducted to provide the information needed to manage this new fishery.

OBJECTIVES

1. Assess the fish community in Deyo Reservoir to determine if changes in management strategies need to occur.

STUDY AREA

Deyo Reservoir is located approximately 5 km west of Weippe, Idaho, at an elevation of 920 m (

Figure 1). It is a 22.3-ha reservoir created by the damming of Schmidt Creek, a tributary to Lolo Creek, Idaho. Deyo Reservoir has a maximum depth of approximately 10 m, a mean depth of approximately 5 m, and a volume of approximately 550 acre/ft. The upper end of the reservoir has been developed into a wetland area to provide habitat for waterfowl and other wildlife. The drainage basin is composed of a mix of forest and cropland. Facilities at the reservoir include a campground with both full hookups and primitive sites, numerous fishing docks (including ADA accessible), boat ramp, picnic pavilion, and toilets.

METHODS

Fish were sampled using boat electrofishing with pulsed D.C. current from a Honda 5000-w generator and an ETS MBS-1DP pulsator. Electrofishing occurred for one hour and was divided into 10 min sample units. Fish collected in each 10 min sample unit were processed and recorded separately. This allows a variance to be calculated around the sample size, and it allows us to generate an estimate of how much shocking time should occur to produce reliable and repeatable survey results (IDFG 2012). Species, length, and weight were recorded for each fish collected.

Proportional Size Distribution (PSD; Guy et al. 2007; Neumann et al. 2012) and relative weights (W_r; Wege and Anderson 1978; Neumann et al. 2012) were calculated for LMB and Bluegill. The PSD for these species were calculated using the following formula:

$$PSD = \frac{\#\ fish \geq quality size}{\#\ fish \geq stock size} * 100$$

Quality size and stock size correspond to lengths considered to be the minimum size at which anglers will first catch the species (stock) and consider the fish to be of desirable size (quality). These lengths are 200 and 300 mm for Largemouth Bass, and 80 and 150 mm for Bluegill (Gablehouse 1984; Neumann et al. 2012). Proportional Size Distribution values of 40 - 70 for Largemouth Bass and 20 - 40 for Bluegill are considered to be indicative of balance (Anderson 1980).

A PSD decision model was developed to diagnose predator-prey dynamics in Deyo Reservoir (Schramm and Willis 2012). This model plots predator (Largemouth Bass) PSD versus prey (Bluegill) PSD. The PSD for predator and prey can each fall into three categories: low, desirable, or high. Thus, there are nine possible predator:prey PSD size structure scenarios. Explanations for each situation and recommended management actions are detailed in Schramm and Willis (2012).

Relative weight (W_r) was calculated to provide information on the condition of fish of various species and lengths:

$$W_r = \frac{W}{W_s} * 100$$

where W is the observed weight of the fish and W_s is the length-specific standard weight predicted by a weight-length regression. This equation is:

$$log_{10}\ Ws = a + (b * log_{10}\, total\ length)$$

where a is the intercept and b is the slope of standard weight equations developed for many fish species (Wege and Anderson 1978; Neumann et al. 2012). Relative weights represented in each population for each species were plotted using scatter plots. Trend lines within this data were used to estimate relative fitness of each species.

Standard two-sample t-tests (assuming equal variance) were used to compare CPUE and mean Total Length between sample years. Significance level of $\alpha = 0.05$ was used for all comparisons.

RESULTS

Deyo Reservoir was night electrofished on May 18, 2015 for six consecutive 10-minute periods. The electrofishing resulted in the capture 1,331 Bluegill and 29 Largemouth Bass (Figure 7). The CPUE for Largemouth Bass declined significantly ($\alpha = 0.05$) from the 53 fish/hour observed in 2014 ($P \leq 0.0477$). The CPUE for Bluegill was higher in 2015 than 2014 (866 fish/hour), but not statistically different ($\alpha = 0.05$; $P = 0.121$).

The LMB collected ranged from 102 to 388 mm in length, with an average length of 200 mm (Figure 8). The average length was statistically different ($\alpha = 0.05$) than the 90 mm average observed in 2014 ($P < 0.0001$). Only four (13.8%) of the 29 fish collected in 2015 were >300 mm in length. Largemouth Bass PSD was 31. Relative weights ranged from 42 - 125, with an average of 96 (Figure 9). Relative weight tended to increase as fish length increased.

The Bluegill collected ranged from 18 to 150 mm in length, with an average of 87 mm (Figure 10). The average length was statistically different ($\alpha = 0.05$) than the 76 mm average observed in 2014 ($P < 0.0001$). Most of the fish (98%) were between 60 - 129 mm. The PSD for Bluegill was 0.1. Relative weights ranged from 43 - 198, with an average of 135 (Figure 11). Relative weight tended to decrease as fish length increased.

DISCUSSION

Largemouth Bass collected in 2015 averaged 200 mm in length at capture, much larger than the 90 mm average in the 2014 sample (Hand et al. 2017). Deyo Reservoir was only stocked three years ago (in 2012), so we should see increased growth rates; however, this is a very large increase in average size. Given the low average annual growth rates experienced by LMB in area reservoirs (31 - 79 mm), an average growth of 110 mm is unlikely (Hand et al. 2016a). While some of this increase is due to annual growth, most of this is likely due to random chance of collecting more of the larger individuals in the population in 2015. In contrast to 2014, when only three bass (5.7%) >140 mm were collected, 24 fish (82.8%) of the fish collected in 2015 were >140 mm. In spite of the change in size of fish collected in 2015, the overall CPUE declined (Figure 7). This is to be expected, as both harvest and natural mortality will continue to reduce the population until natural reproduction and/or additional stockings can make up for those losses.

With no LMB <100 mm collected in 2015, recruitment appears to be very low (Figure 8). The large numbers of small Bluegill in the reservoir has likely made successful spawning and recruitment of LMB nearly impossible due to predation and competition for food resources (Anderson and Weithman 1978; Guy and Willis 1991). This is common in small impoundments when predator:prey dynamics are out of balance with few predators to control the overcrowding of prey species (Aday and Graeb 2012). However, the low numbers of juvenile bass may also be a result of low numbers of sexually mature LMB and limited reproduction from fishing/natural mortality.

The low number of fish >300 mm resulted in a PSD value of 31, below the balanced population range of 40 - 60 (Schramm and Willis 2012). Low PSD is often an indicator of a stunted population of LMB and/or overharvest of fish by anglers (Schramm and Willis 2012). With the reservoir being stocked in 2012, the LMB population has not had time to expand to its full potential, and is not likely to be experiencing stunting at this time. The lack of LMB >300 mm collected in the population survey is concerning, and indicates that harvest and natural mortality are having a large effect of the number of LMB in this size range. With approximately 125 LMB >300 mm stocked in 2012, even low harvest levels would have a large impact on the population once natural mortality is taken into account. Creel surveys of Deyo Reservoir estimated that 311 LMB were caught and 21 harvested in 2014. Assuming that the fish harvested were the larger fish stocked in 2012, approximately 17% of those fish were estimated to have been harvested in 2014 alone. Some were likely harvested in 2012 and 2013 as well. This exploitation rate is within range of angler exploitation rates of 8% - 35% calculated for several regional reservoirs (Hand et al. 2017). It is also below the average fishing mortality rate of 30% for 32 separate LMB populations calculated by Allen et al. (2008). However, with no fish over age two in population other than those originally stocked, there is no replacement of those larger fish occurring at this time. Harvest will therefore have a larger impact than normal until naturally spawned fish are old enough and large enough to replace those lost.

Due to the impact of harvest on the LMB population, restrictive regulations should be implemented to improve the size structure of the population and improve recruitment. Length limits, such as a minimum length or a protective slot, should be considered. Minimum length limits are recommended for fish populations that exhibit low rates of recruitment and natural mortality, good growth rates, and high fishing mortality (Novinger 1984; Wilde 1997). They are generally used to protect the reproductive potential of fish populations, prevent overexploitation, increase angler catch rates, and promote predation on prey species (Noble and Jones 1993; Maceina et al. 1998; Iserman and Paukert 2010).

Slot limits are recommended for populations with high recruitment and low growth rates. They are used to increase numbers of the protected size fish, promote growth of smaller fish by reducing competition (through harvest), and increase abundance of larger fish (Anderson 1976; Iserman and Paukert 2010). Slot limits for predatory fish such as Largemouth Bass can also be used to manipulate prey fish populations by allowing the predators to grow larger (Anderson 1976). The previously mentioned study by Wilde (1997), and a study of 14 small mid-western reservoirs by Novinger (1990), indicate that slot limits were successful in restructuring Largemouth Bass populations by increasing population size and the number of both quality and preferred size fish (and thus increased PSD), but did not increase angler catch rates or harvest rates. When slot limits do fail to restructure Largemouth Bass populations, it is usually because anglers harvest few fish below the slot limit (Gablehouse 1987; Summers 1990; Martin 1995). This effectively results in a minimum size limit. This may be an issue in Deyo Reservoir, as most of the fish in the population are <150 mm in length, and not likely to be caught or harvested (Figure 8). However, creel surveys of regional reservoirs in 2012 indicated that anglers harvested fish down to 150 mm (Hand et al. 2016a), so it is possible that anglers would harvest some fish below a 305-mm minimum size limit.

The Bluegill collected in this survey averaged 87 mm, with most of the fish (98%) between 60 and 129 mm (Figure 10). This is approximately a 10-mm increase in average size from 2014 (Hand et al. 2017). This increase, in conjunction with the high relative weights, indicates that this population is experiencing good growth and reproduction. However, the Bluegill population in Deyo Reservoir is dominated by small fish, as indicated by the very low PSD value (0.1). This PSD value is well below the range of 20 - 40 considered to be in balance. With only three years of reproduction, this is to be expected. It will take several more years to have a fully-developed population. However, with so many smaller fish and few predators, there is concern that Bluegill could overpopulate. The large increase in CPUE indicates that this may be occurring.

Warm-water Fishes Predator:Prey Dynamics:

A comparison of predator and prey PSD values can provide a good assessment of population balance (Schramm and Willis 2012). In Deyo Reservoir, the 2015 sample landed in Cell 7 (Figure 12). Fish communities fall into Cell 7 when both predator and prey PSDs are low. This is usually caused by overabundant Bluegill, low predation levels by LMB, and/or overharvest of larger Bluegill. In Deyo Reservoir, the reason for this assessment is because it is a newly established fishery which needs more time for fish to grow to larger sizes. In addition, evidence suggests that anglers are harvesting the larger LMB stocked into the reservoir in 2012, resulting in reduced recruitment and predation of Bluegill.

To increase the number of larger sized LMB we recommend stocking additional LMB >300 mm each year over the next few years to improve the size structure of the population, and increase predation on Bluegill. Additionally, we recommend implementing a 406-mm minimum size limit with a two fish bag limit to reduce harvest of larger LMB, improve their size structure, and increase predation on Bluegill. Minimum length limits are a commonly-used restrictive regulation, and are generally implemented to protect the reproductive potential of fish populations, prevent overexploitation, increase angler catch rates, and promote predation on prey species (Noble and Jones 1993; Maceina et al. 1998; Iserman and Paukert 2010). By improving the predator size structure, predation on Bluegill and Pumpkinseed should increase, potentially improving the size structure of these species as well. However, the effects of the minimum size limit for LMB will take some time to become apparent due to the slow growth seen in SVR and other area reservoirs (Hand et al. 2016a).

MANAGEMENT RECOMMENDATIONS

1. Stock 150 Largemouth Bass >300 mm in 2016 and 2017 to improve predation on smaller Bluegill and continued reproductive success as larger fish are harvested.

2. Implement a 406-mm minimum size limit, with a two-fish bag limit for Largemouth Bass to reduce harvest of larger fish and to increase the amount of predation on small Bluegill.

Table 2. Number of fish collected by species in each 10-minute electrofishing sample conducted during a standard lowland lake survey of Deyo Reservoir, Idaho, in 2015.

	Count of fish collected									
Species	EF Sample	EF Sample	EF Sample	EF Sample	EF Sample	EF Sample	Total	Mean	SD	n
Largemouth Bass	0	6	6	6	2	9	29	4.8	3.3	20
Bluegill	56	87	218	351	215	404	1331	221.8	138.3	17
Total	56	93	224	357	217	413	1360	226.7	140.6	17

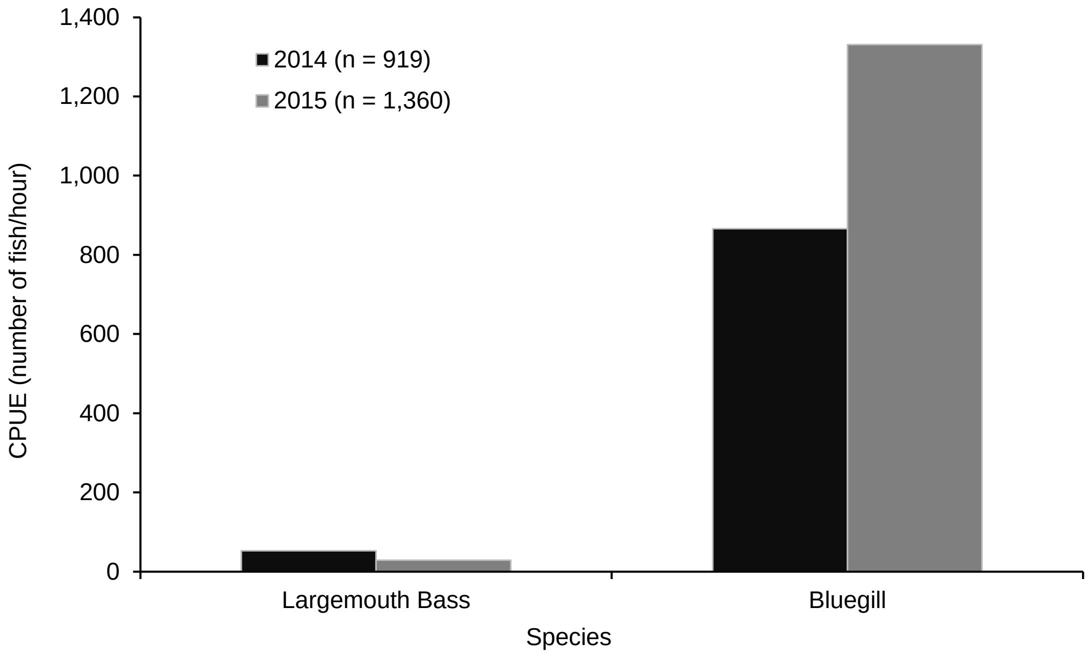

Figure 7. Catch per unit effort (CPUE; number of fish/hour) of fishes collected during standard lake surveys of Deyo Reservoir, Idaho, in 2014 and 2015.

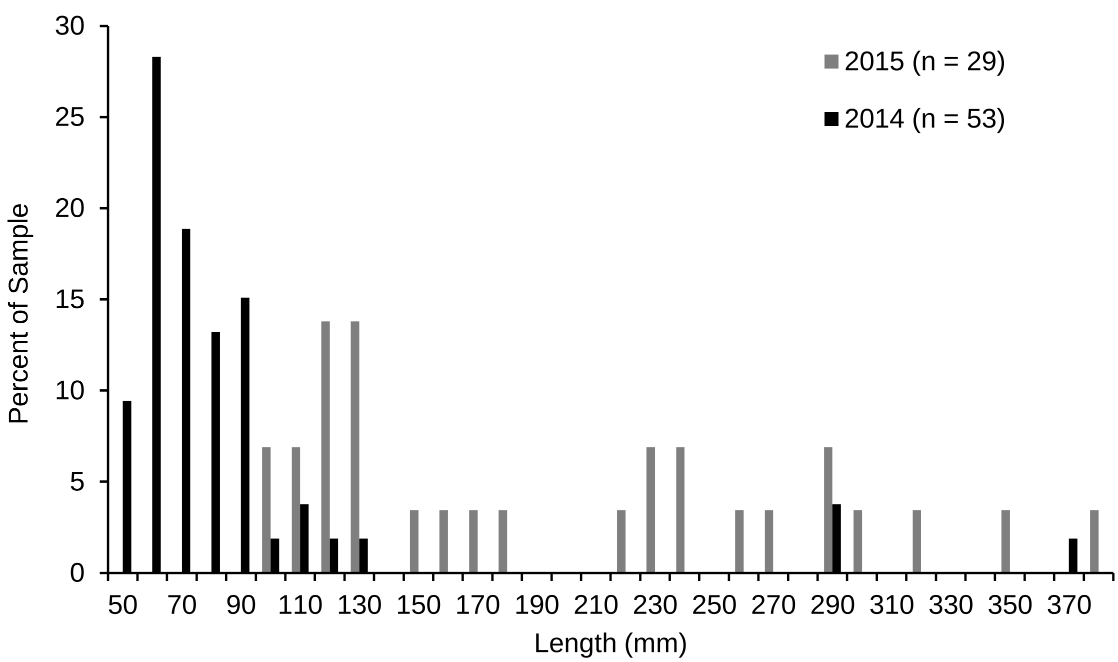

Figure 8. Length-frequency distribution of Largemouth Bass collected through electrofishing of Deyo Reservoir, Idaho, in 2014 and 2015.

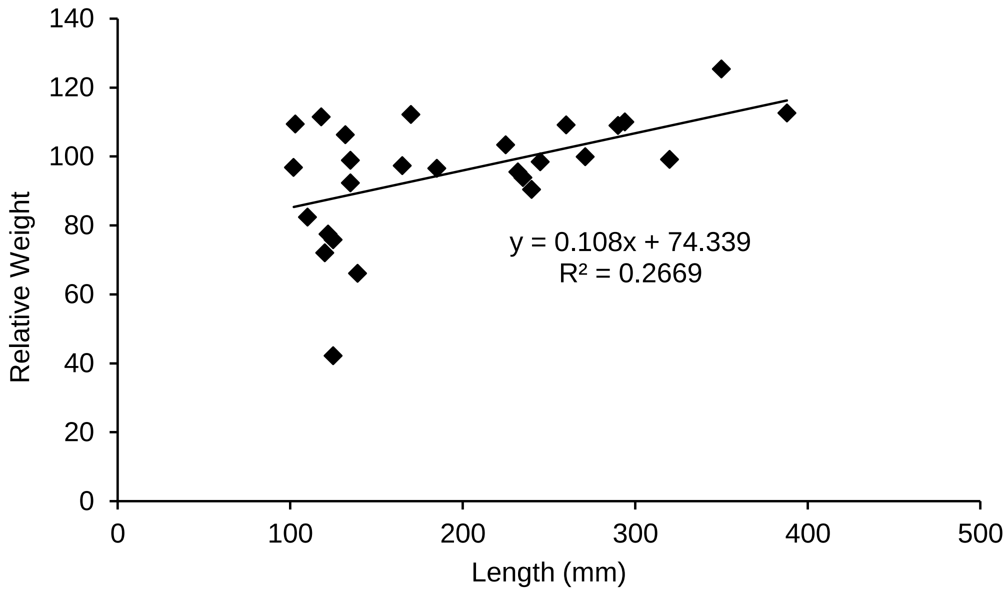

Figure 9. Relative weight (W_r) values of Largemouth Bass collected through electrofishing of Deyo Reservoir, Idaho, in 2015.

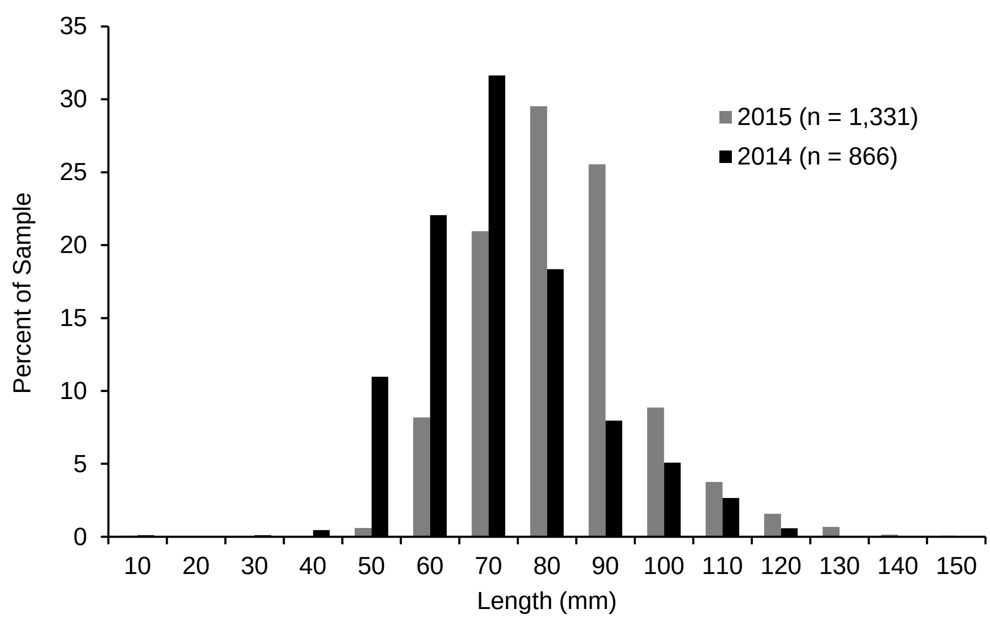

Figure 10. Length-frequency distribution of Bluegill collected through electrofishing of Deyo Reservoir, Idaho, in 2014 and 2015.

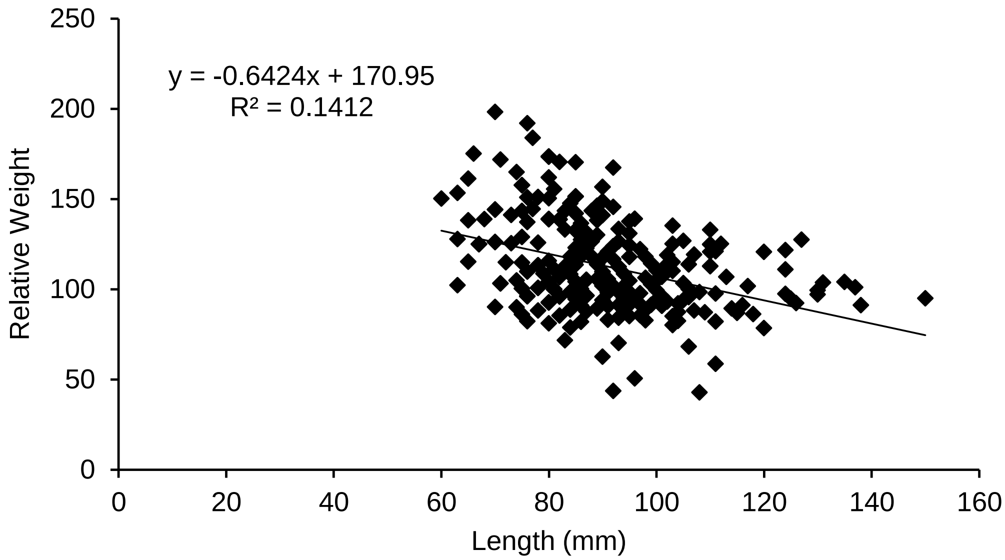

Figure 11. Relative weight (W_r) values of Bluegill collected through electrofishing of Deyo Reservoir, Idaho, in 2015.

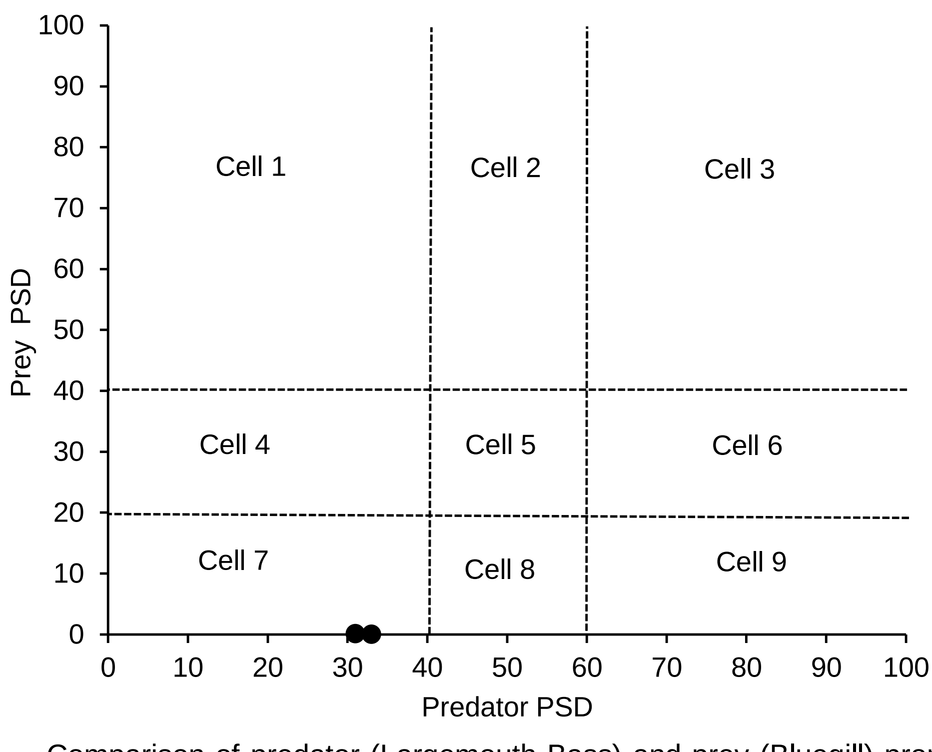

Figure 12. Comparison of predator (Largemouth Bass) and prey (Bluegill) proportional size distribution (PSD) collected through electrofishing in Deyo Reservoir, Idaho, in 2014 and 2015. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

SOLDIER'S MEADOW RESERVOIR KOKANEE EVALUATION

ABSTRACT

Soldier's Meadow Reservoir (SMR) was gillnetted in November 2015 to evaluate a newly established kokanee *Oncorhynchus nerka* fishery. A total of 185 kokanee were collected, with an average length of 251 mm. This was an increase in the average size (172 mm) of what was observed in 2014. Additionally, the average lengths of age-0 (140 mm) and age-1 (265 mm) kokanee collected in SMR in 2015 were above the averages for numerous other Idaho and Washington reservoirs. Part of our evaluation of the fishery was to determine if early or late spawning strains would grow and survive better in SMR. Although equal number of early and late spawners were stocked, significantly more early spawners were caught, and the average lengths of the early spawners were significantly larger in both 2014 and 2015. It is recommended to gillnet SMR again in 2016 and to assess the zooplankton populations to determine whether it is sufficient to allow kokanee to reach desired sizes (for anglers) before they reach sexual maturity (2 - 3 years old).

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INTRODUCTION

Soldier's Meadow Reservoir (SMR) was renovated in 2013 with rotenone to remove stunted Yellow Perch *Perca flavescens*, Black Crappie *Pomoxis nigromaculatus*, and Black Bullhead *Ameiurus melas* populations (Hand et al. 2016b). Following this management action, SMR was primarily managed as a put-grow-take kokanee *Oncorhynchus nerka* fishery with a minor put-take Rainbow Trout *Oncorhynchus mykiss* fishery. The decision to introduce kokanee and Rainbow Trout was based on preferences indicated by anglers through email surveys and public meetings following the renovation (Hand et al. 2016b). In May 2014, 8,057 Kokanee fry were stocked (approximately equal numbers of early and late spawning strains), and in May and June 2014, 10,494 Rainbow Trout of catchable size were stocked.

The current objectives are to evaluate SMR potential for providing a kokanee fishery, and to evaluate growth and survival of early versus late spawning kokanee strains. Additionally, we will monitor zooplankton to help evaluate future food availability and reservoir health.

OBJECTIVES

1. Evaluate the potential of kokanee to provide a fishery in Soldier's Meadow Reservoir.

2. Evaluate growth and survival of early versus late spawning kokanee.

STUDY AREA

Soldier's Meadow Reservoir is located approximately 45 km southeast of Lewiston Idaho, and 10 km west of Winchester, Idaho (

Figure 1). It is a 47.8-ha reservoir with a mean depth of 5.6 meters and a maximum depth of 14.0 meters and lies at an elevation of 1,378 meters. Soldier's Meadow Reservoir was constructed for the Lewiston Orchards Irrigation District (LOID) to retain water for irrigation purposes. Its primary water supply is from Webb and Captain John creeks. Water-level fluctuations up to eight meters on an annual basis are commonplace. Drawdowns usually begin by late June or early July as water is discharged for storage in Mann Lake. Low pool is generally reached by late fall towards the end of the irrigation season. Full pool is generally reached in May during spring runoff. Severity and timing of water-level fluctuations is dependent on water yield in the LOID-managed watershed and irrigation demand. The timing of annual variations in water level can have major effects on the spawning success of warm-water species. Also, low pool levels through the winter can reduce carrying capacity of fishes. Facilities at this reservoir include primitive camping, a boat ramp, and a toilet.

METHODS

Fishes were sampled using overnight gill net sets (Hand et al. 2012). Floating style and sinking style monofilament gill nets 36-m long and 1.8-m high were used. The nets were divided into six equal size panels with bar mesh sizes of 10, 12.5, 18.5, 25.0, 33.0, and 38.0 mm. Monofilament diameter ranged from 0.15 - 0.20 mm. Sampling in 2015 consisted of two floating and two sinking gill nets. For the purpose of this evaluation, fish species, lengths (total length, mm), weights (g), and otoliths were collected. Gill nets were placed in locations that were >2 m in depth and allowed for the net to be fully stretched out perpendicular to the shoreline. Prior to stocking, kokanee were subjected to temperature changes to produce unique marking patterns (thermal marks) in the otolith that could be used to differentiate between early and late spawning strain (Volk et al. 1990; Hagen et al. 1995).

Standard two-sample t-tests (assuming equal variance) were used to compare mean Total Length between spawner types and sample years. Significance level of $\alpha = 0.05$ was used for all comparisons.

RESULTS

Overnight gill net sets were conducted on November 19 - 20, 2015 in SMR. We collected 185 kokanee and 8 Rainbow Trout. Kokanee ranged in length from 115 to 315 mm, and averaged 251 mm (Figure 13). Rainbow Trout collected ranged in length from 280 to 364 mm, and averaged 305 mm (Figure 14). This resulted in a CPUE of 46 fish/net for kokanee and 2 fish/net for Rainbow Trout. The sinking nets caught more kokanee ($n = 104$) than the floating nets ($n = 81$), while the floating nets caught more Rainbow Trout ($n = 6$) than the sinking nets ($n = 2$). Relative weight values for kokanee ranged from 64 to 110, and averaged 89 (Figure 15). Relative weights were generally higher for larger fish.

Otolith thermal marks were identified for 179 of the 185 kokanee collected. Thermal marks for the other six fish were indistinguishable and therefore not included. Fish from all four mark groups were identified, including 2014 Early Spawners ($n = 138$), 2014 Late Spawners ($n = 23$), 2015 Early Spawners ($n = 13$), and 2015 Late Spawners ($n = 5$; Figure 16). Average lengths for kokanee were 266 mm for 2014 Early Spawners, 257 mm for 2014 Late Spawners, 146 mm for 2015 Early Spawners, and 124 mm for 2015 Late Spawners (Figure 16). Average lengths between spawner type were statistically different ($\alpha = 0.05$) for both 2014 ($P = 0.0104$) and 2015 ($P = 0.0050$).

DISCUSSION

Kokanee fry were stocked into SMR in May, 2014 and 2015 in order to establish a new fishery following a 2013 renovation project. When collected through gillnetting in November, 2015, the average length of kokanee stocked in 2014 had increased 93 mm (172 to 265 mm) since being sampled in November 2104. We suspect that these fish will exceed 300 mm next year and should provide desirable-sized kokanee for anglers to catch.

The average length of age-0 fish was 140 mm, compared to 172 mm in 2014. This decline in age-0 growth was also expected, as the increase in number and size of fish in the reservoir impacts the available food resources. Like other fish species, kokanee growth and average length at age is generally density dependent (Reiman and Myers 1992; Walters and Post 1993). As we conduct additional stocking in the next few years, fish density and biomass will increase. This will likely reduce average size and annual growth over what was seen in the first year. Future surveys will be important to evaluate the success of these stockings and to determine what stocking densities are needed to maintain desired growth and catch rates. In addition to fish surveys, creel surveys should be conducted to evaluate angler effort, catch rates, and satisfaction.

The average lengths of age-0 (140 mm) and age-1 (265 mm) kokanee collected in SMR in 2015 were substantially above the averages for numerous other Idaho and Washington reservoirs (Table 3). The kokanee captured in SMR also had a wider range of sizes of individuals caught compared to Dworshak Reservoir, probably due to the fact that both early and late spawner types were stocked into the reservoir (Wilson et al. 2013). These two stocks hatch at different times, causing the late spawners to be slightly smaller at stocking time. Early spawners average approximately 76 mm at stocking compared to approximately 57 mm for late spawners.

Part of our evaluation of the fishery was to determine if early or late spawner strains would grow and survive better in SMR. For fish stocked in both 2014 and 2015, the average lengths for the early spawner strain were significantly larger. In addition, with more early spawners captured for both stocking year, survival appears to be better for the early spawner strain as well. We will continue to monitor this over the next few year, but preliminary evidence suggests that the early spawner strain survives better and grows larger in SMR. This is to be expected, given the larger size at stocking for early spawners. We would expect fish stocked at a larger size to grow faster and survive at better rates than those stocked at smaller sizes.

Zooplankton sampling should be conducted over the next few years to determine whether their abundance and size is sufficient to allow kokanee to reach desired sizes (for anglers) before they reach sexual maturity (2 - 3 years old). Based on kokanee growth and harvest, adjustments can be made to stocking abundance to help meet management goals.

One important concern we have with the potential success of kokanee in SMR is the annual water drawdowns that occur in this reservoir due to irrigation. There is uncertainty as to whether overwinter survival will be sufficient enough to maintain a fishery. Thus, we will continue to monitor the kokanee population over the next few years. Additionally, the annual drawdown combined with the lack of a suitable stream, will likely eliminate the potential for natural spawning in SMR. If this program proves to be successful, it will be fully dependent on annual stocking.

MANAGEMENT RECOMMENDATIONS

1. Continue to assess the kokanee population in 2016 to determine the success of this fishery.

2. Conduct angler surveys utilizing in-person interviews and angler self-report boxes to provide information on effort, catch and harvest.

Table 3. Comparison of kokanee average length at age in Idaho reservoirs.

		Length (mm)		
Water Body	Survey Year	Age-0	Age-1	Age-2
Lake Pond Orielle[a]	2010	63	148	219
Priest Lake[b]	2010	40	180	265
Cour D'Alene Lake[c]	2011	40	110	170
Deadwood Reservoir[d]	2011	<100	100-200	200-300
Payette Lake[e]	2011	45-58	105-133	---
Spirit Lake[c]	2011	50	160	190
Devil's Creek Reservoir[f]	2012	@120	@280	---
Dworshak Reservoir[g]	2013	84	222	270
Soldier's Meadow	2015	140	265	---

[a]Wahl et al. (2011) [d]Butts et al. (2013) [f]Brimmer et al. (2013)
[b]Maiolie et al. (2011) [e]Janssen et al. (2012) [g]Wilson et al. (2013)
[c]Fredericks et al. (2013)

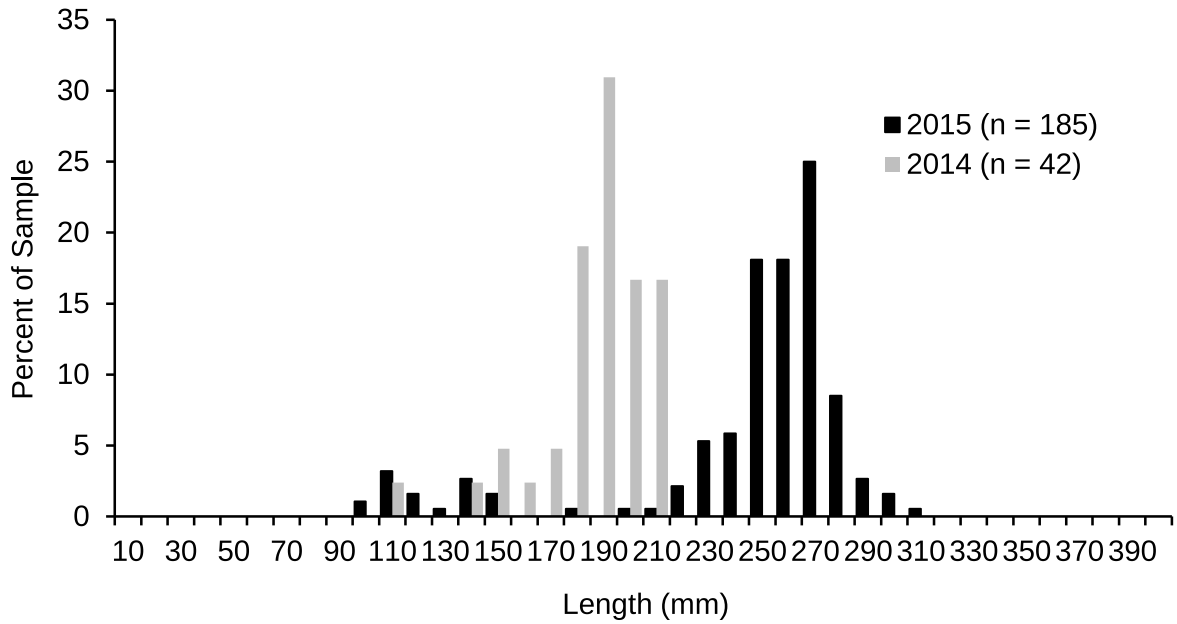

Figure 13. Comparison of length-frequency distributions of kokanee collected by gill nets in Soldier's Meadow Reservoir, Idaho, in 2014 and 2015.

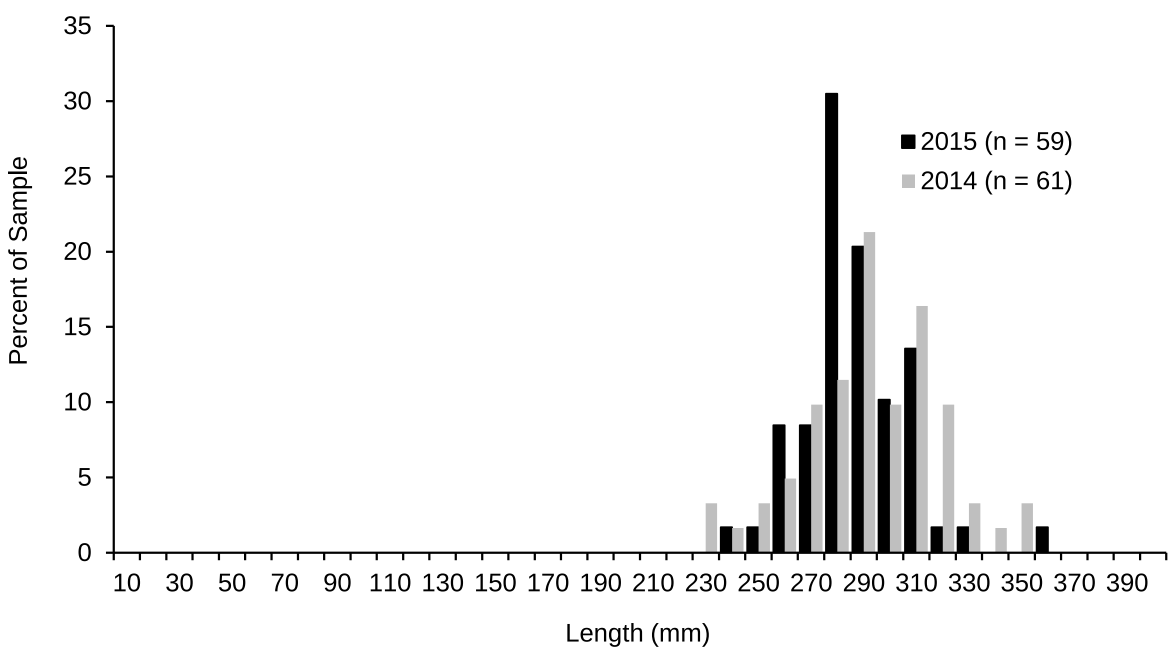

Figure 14. Comparison of length-frequency distributions of Rainbow Trout collected by gill nets in Soldier's Meadow Reservoir, Idaho, in 2014 and 2015.

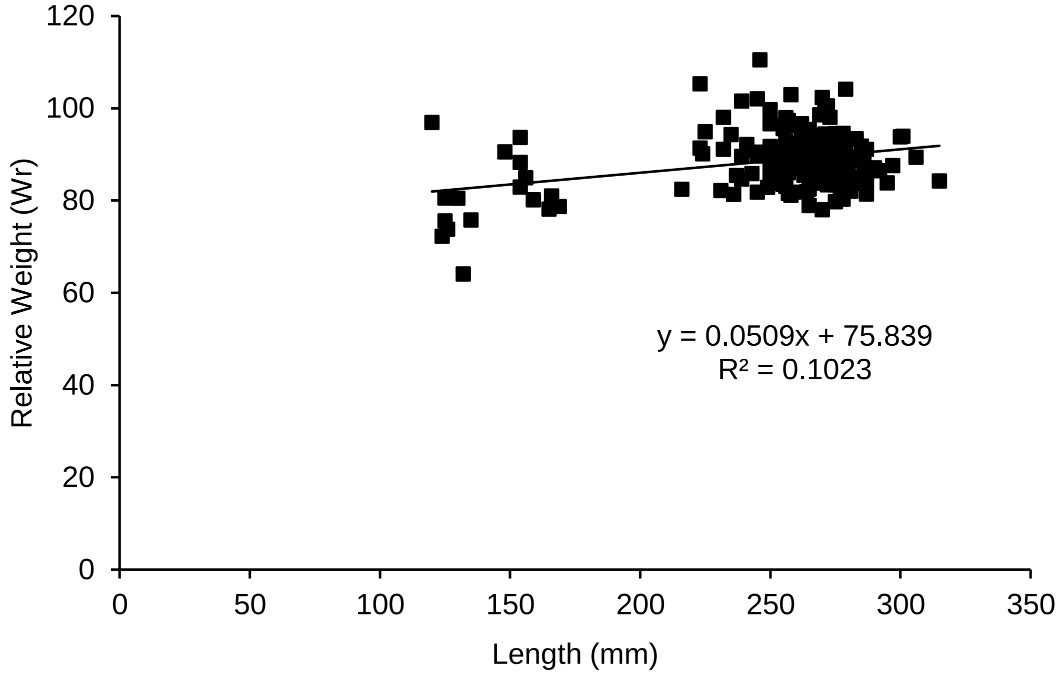

Figure 15. Relative weight values of kokanee collected during a standard lake survey of Soldier's Meadow Reservoir, Idaho, in 2015.

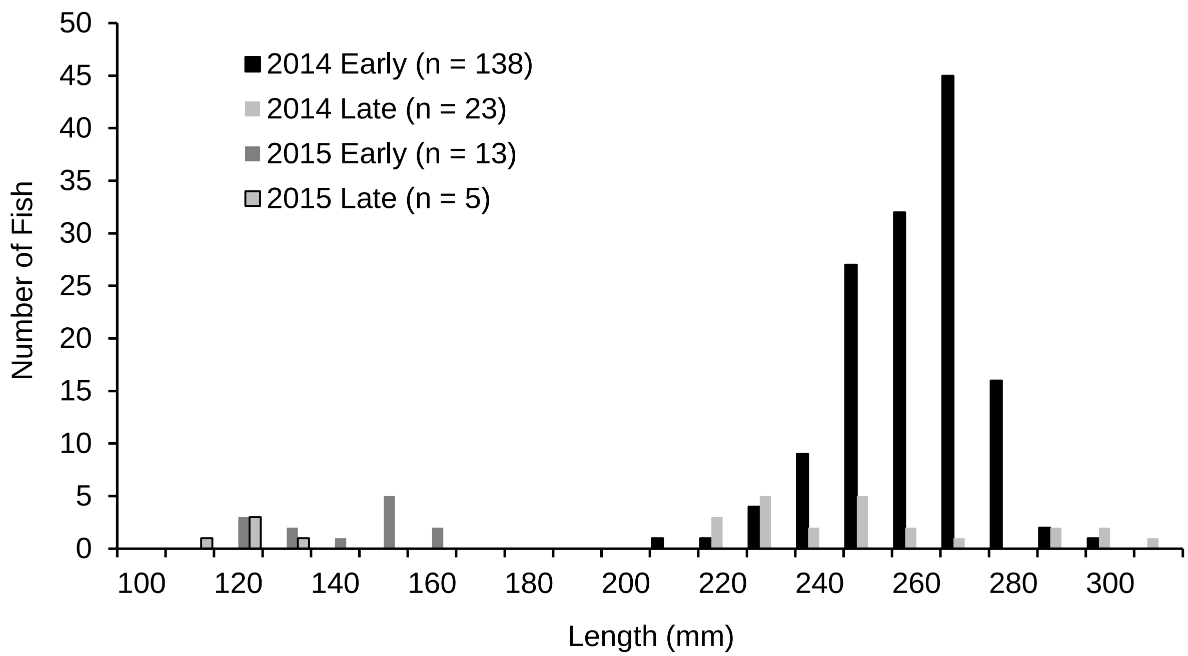

Figure 16. Comparison of length frequency distributions of kokanee collected by gill nets in Soldier's Meadow Reservoir, Idaho, in 2014 and 2015, based on stocking year and spawner type.

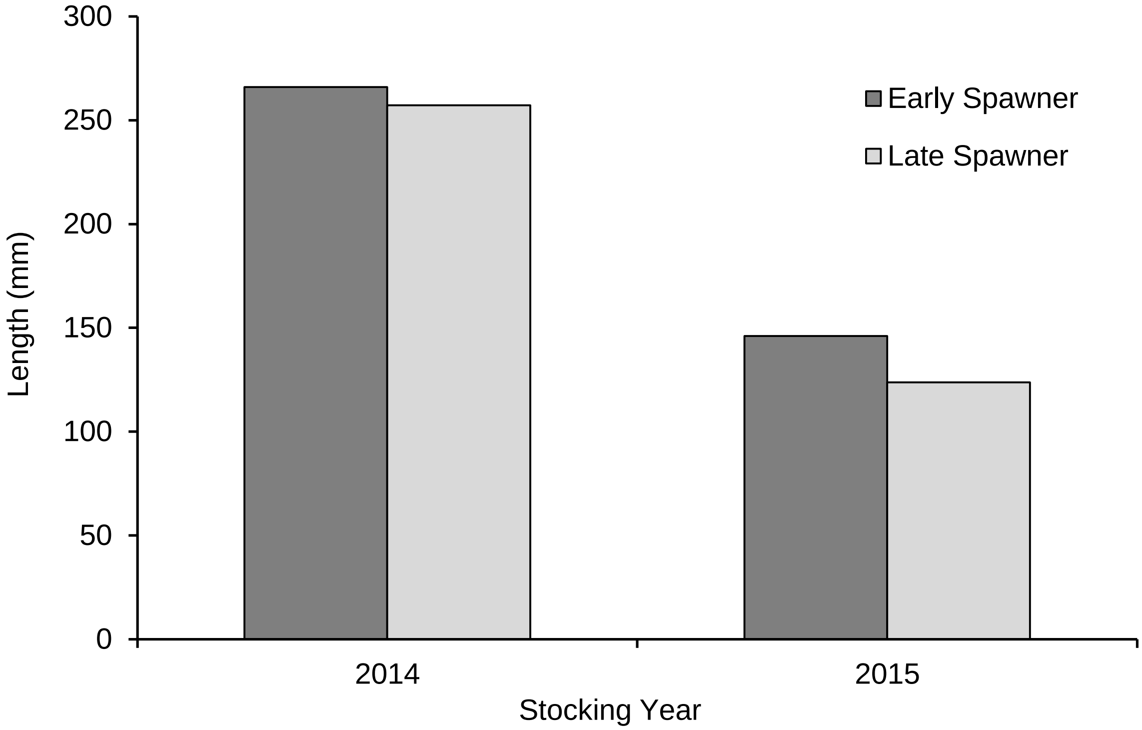

Figure 17. Comparison of mean total length (mm) at capture for kokanee collected in Soldier's Meadow Reservoir, Idaho, in November 2015, by stocking year and spawner type.

EFFECTS OF DRAWNDOWN ON SPRING VALLEY RESERVOIR

ABSTRACT

In 2015, IDFG initiated a pilot project to evaluate the effectiveness of releasing water from Spring Valley Reservoir (SVR) to benefit steelhead *Oncorhynchus mykiss* rearing downstream. Because this release of water would increase the drawdown of SVR, we initiated surveys to assess the potential impacts this drawdown would have on the fishery and angler satisfaction. The water release resulted in a total drawdown of 1.07 m, of which approximately 0.61 m was due to the water release, and 0.46 m due to evaporation and seepage. The fish survey resulted in the capture of 537 fish, including Largemouth Bass *Micropterus salmoides*, Bluegill *Lepomis macrochirus*, Pumpkinseed *L. gibbosus*, and Black Crappie *Pomoxis nigromaculatus*. The data collected in 2015 will provide a baseline to compare with surveys conducted in the future. Angler surveys consisted of 130 in-person interviews and 111 self-report cards. Sixty-three percent of the people interviewed rated their fishing experience as excellent or good compared to 57% in 2012. In addition, angler catch rates did not drop from 2012 to 2015. These data suggests that the increase in water drawdown did not have a negative effect on angler experience.

The fish survey indicated a very low Proportional Size Distribution (PSD) value for Largemouth Bass, indicating a lack of fish >300m. In order to improve the population, we recommend implementing a 406-mm minimum length regulation and two fish bag limit for LMB. These regulations should improve the predator size structure, and increase predation on prey species, potentially improving the size structure of these species as well.

If the water releases into Spring Valley Creek are successful, this program may be implemented on a long-term basis, resulting in drawdowns annually in SVR. One issue that we foresee in the future is the reduced access to the reservoir from docks, the boat ramp, and shoreline that occurs due to the drawdown. Thus, we will need to be proactive with maintaining access to the reservoir. Projects such as reducing the walkway angles on docks, adding stepped concrete fishing platforms that would allow access at a variety of water levels, and increasing the volume of water available in the top 1 - 2 meters of the water column (to reduce the vertical drop in water level) should be considered to maintain access to the reservoir. These, and other potential alternatives, will require further research to develop the best option(s) based on available funding.

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INTRODUCTION

In 2015, IDFG initiated a pilot project to evaluate the effectiveness of releasing water from Spring Valley Reservoir (SVR) to benefit steelhead *Oncorhynchus mykiss* rearing downstream. This project was designed to use minimal water releases (<1.0 cfs) from SVR from July - September to maintain base flows in Spring Valley Creek when the creek often goes dry. Accompanied with this release of water would be an increased drawdown of SVR. The water level in SVR is managed through the use of dam boards fitted on the spillway. These boards are installed each spring after peak run-off in order to capture some of this water and increase the maximum level of the reservoir during the peak recreation season (spring-summer). During the course of a typical summer, the water level SVR generally drops approximately 0.67 m due to evaporation and seepage.

Spring Valley Reservoir is an important fishery in the Clearwater Region's lowland lake program given its close proximity to the local population centers of Moscow, ID and Pullman, WA. Spring Valley Reservoir is the closest public fishery to both of these communities and therefore receives high levels of angler effort. An economic survey conducted in 2011 estimated anglers took 10,507 trips to Spring Valley Reservoir and spent $382,791 in their efforts to do so (IDFG unpublished data). Due to its recreational and economic importance, we initiated fish population and angler surveys of SVR to assess the potential impacts the increased drawdown might have on the fishery and angler satisfaction.

OBJECTIVES

1. Monitor effects of reservoir drawdown on fish populations and angler satisfaction in SVR.

STUDY AREA

Spring Valley Reservoir is a 19.8-ha reservoir located in Latah County approximately 13 km east of Troy, Idaho at an elevation of 726 meters (Figure 1). It is approximately 29 km from Moscow, ID (pop. 24,080) and 44 km from Pullman, WA (pop. 29,913). It has a mean depth of 3.6 meters, a maximum depth of 8.8 meters, and a maximum volume of 735 acre-ft. The reservoir is characterized as eutrophic and is prone to algal blooms in the late summer. The surrounding watershed is dominated by timberlands with some limited agricultural areas above the reservoir. Spring Valley Reservoir was originally constructed in 1961 by IDFG to create a recreational fishery. In 1993, the spillway was reconfigured to meet the dam safety specifications of the Idaho Department of Water Resources. Facilities at the reservoir include a boat ramp, picnic pavilion, vault toilets, numerous ADA accessible fishing docks, and primitive camp sites.

METHODS

The water release from SVR occurred from August 3 - October 21, 2015. It was initiated once Spring Valley Creek below the reservoir became dry. The release schedule was 0.5 cfs for three weeks beginning in August, and then increasing to 1.0 cfs. Once the creek was charged from the 1.0 cfs release, the release was reduced back to 0.5 cfs for the remainder of the study.

Limnology sampling, consisting of dissolved oxygen (DO) and temperature profiles, were conducted on a monthly basis. Dissolved oxygen (DO) and temperature profiles were taken from a boat with a YSI model 550A meter at the surface and 1 m increments down to the bottom of the reservoir. The boat was kept stationary in the deepest part of the lake while measurements were taken. Temperature was recorded in ˚C, and DO in mg/L.

Angler surveys were conducted using self-report cards and in-person interviews. Self-report cards were utilized from June 15 - November 13, 2015. In-person creel surveys were conducted on 12 different days occurring from August 10 - October 30, 2015. The surveys included eight week days and four weekend days. In-person surveys were conducted when scheduling allowed, and were not randomly selected or stratified. Thus, estimates of expanded effort, catch, and harvest estimates were not appropriate.

For in-person interviews, creel clerks parked at the main access point to SVR. All anglers and non-anglers leaving the lake during were interviewed to collect completed trip data. Total hours fished, number of fish caught, fish species, and fish lengths were recorded during interviews. Each angler was interviewed separately and not as a group. Angler opinion surveys were also conducted in conjunction with the creel surveys (Table 4).

Angler survey cards and on-site return boxes were used to increase the number of completed trip interviews (Figures 18 and 19) (Hand et al. 2017). The return box had blank survey cards on the side that anglers could self-report creel data when no creel clerks were present. Additionally, at the end of each in-person creel survey, creel clerks handed out self-report cards to the remaining anglers to collect additional completed trip information. Each card was labeled with the date and interview ID so that catch, harvest, and effort data collected during in-person incomplete trip surveys could later be revised to a completed trip survey.

The fishery in SVR was sampled in 2015 through electrofishing using the same methodology as described previously in the chapter titled “Deyo Reservoir Fishery Evaluation”. Night electrofishing was conducted on May 19, 2015. This sampling consisted of six 10-minute sample periods, for a total of 3,600 seconds of electrofishing effort.

RESULTS

The water release from SVR was conducted from August 3 - October 21, 2015. Measured discharge ranged from 0.40 - 0.97 cfs. The total volume released from the reservoir was estimated at 107.9 acre/ft. Based on bathymetric map and reservoir volumes calculated by DuPont et al. (2011), this equated to a 0.61 m vertical drop in water level. The reservoir reached a maximum drawdown of 1.07 m below full pool on September 30 (Figure 20). Thus, approximately 0.46 m of vertical drop was due to evaporation and seepage.

Limnology samples were collected from early August - late October, 2015. Sampling indicated that the thermocline occurred around 3 - 4 m below the surface during August and September, then moved deeper in October (Table 5). Dissolved oxygen levels remained above 5.0 mg/L minimum for Rainbow Trout in the epilimnion throughout the sample period. Water temperatures in the August sample were above 21 ^{o}C throughout the epilimnion. However, temperatures dropped to a high of 16.8 ^{o}C in September. These trends in DO levels and water temperature were consistent with previous sampling (Hand et al. 2017).

Creel and angler opinion surveys were conducted during the water release to provide information regarding potential impacts of lower water levels on fishing and angler satisfaction. A total of 216 public opinion surveys were conducted at SVR in conjunction with the creel survey.

All constituents using the lake were interviewed; however, some people chose not to answer some questions. Fifty-eight percent identified fishing as their primary reason for visiting SVR, compared to 63% in 2012 (Figure 21). Camping and picnicking were the next most common responses at 5% and 2% (both values were the same as 2012). Of the people interviewed, 65% had a current fishing license, a decline from 76% in 2012.

Those people who were fishing were also asked additional questions regarding their fishing experience that day. The most commonly targeted fish species was hatchery Rainbow Trout (46%), similar to 2012 (Figure 22). Forty-five percent of people interviewed were not targeting a particular fish species while fishing. Warm-water species comprised only 9% of the targeted fish species responses for SVR (Figure 22). Sixty-three percent of people interviewed rated their fishing experience as excellent or good, comparable to 57% in 2012 (Figure 23). However, it must be noted that the percentage who rated their experience as "excellent" dropped from 22% in 2012 to 7% in 2015. The most common reasons for a positive rating were "nice to be outside" (24%) and "good fishing" (18%) (Figure 24). Thirty-seven percent of people interviewed rated their fishing experience as fair or poor (Figure 23). The most common reasons for a negative rating were related to poor fishing (18%) (Figure 24). This was a substantial drop from 30% in 2012.

Catch rate and harvest data for the 2015 creel survey on SVR was based on 130 complete trip interviews and 111 self-report cards. These anglers fished a total of 582 hours, and caught a total of 708 fish. The majority of these fish caught were hatchery Rainbow Trout (72.3%) followed by Largemouth Bass (22.6%). This was a catch rate of 1.2 fish/h for all species combined. The Rainbow Trout catch rate was 0.9 fish/h. Anglers harvested an estimated 310 (43.8%) fish with Rainbow Trout (n = 280) and LMB (n = 27) accounting for the majority of this harvest (Table 6).

An electrofishing survey of SVR was performed on May 19, 2015. A total of 537 fish were collected, including Largemouth Bass *Micropterus salmoides* (LMB) (n = 167), Bluegill *Lepomis macrochirus*, Pumpkinseed *L. gibbosus*, and Black Crappie *Pomoxis nigromaculatus* (Table 7). However, due to a data collection error, all species other than LMB were recorded as Bluegill. This prevented us from evaluating the data for these species.

Largemouth Bass collected ranged from 72 - 511 mm in length (Figure 25), with an average length of 205 mm. Seven fish sampled (4%) were >305 mm in length. Largemouth Bass CPUE (167 fish/h) was below average, but improved from the lows seen in 2010 (88 fish/h) and 2012 (91 fish/h). Largemouth Bass PSD was 6, the lowest value of any survey from 1997 - 2015 (Figure 26). Relative weights of LMB ranged from 76 - 121 with an average of 91 (Figure 27). This is similar to what was seen in 2012. Relative weight was generally higher for larger fish than for smaller fish.

DISCUSSION

Monitoring the effects of the drawdown at SVR will be crucial for the management of this fishery in the future. If the water releases into Spring Valley Creek prove successful, this program may be implemented on a long-term basis resulting in drawdowns annually in SVR. The biggest concerns we have for SVR in relation to this flow enhancement project are the potential impacts on the fish population and angler satisfaction. A declining fishery and/or reduced angler satisfaction at SVR would likely reduce recreational usage (including angling) of the reservoir. If this program continues, information collected from this and follow up assessments will help us understand any impacts that are occurring and strategies that can be used to maintain high levels of angler satisfaction and a desirable fishery.

Limnology sampling conducted from early August - late October, 2015 indicated that DO levels remained above 5.0 mg/L in the epilimnion throughout the sample period. However, water temperatures in the August sample were above 21ºC throughout the epilimnion. Temperatures above 21ºC can negatively impact Rainbow Trout. These trends in DO and temperature were consistent with previous samples, therefore indicating that the drawdown conducted during this time period in 2015 did not have a negative impact on these limnological variables.

The fishery data collected in 2015 was intended to provide baseline data to help evaluate how draw down might influence this fishery. Unfortunately, this data will be limited to finding on Largemouth Bass due to data recording errors. Additional surveys will be needed to assess all fish species. The fish population survey resulted in CPUE and PSD values well below those seen in recent surveys, including the lowest PSD value of any sample since 1997 (Figure 28). With few LMB >300 mm in length in the population, and slow growth due to short growing seasons, even low levels of harvest could impact the population. As such, we recommend implementing restrictive regulations for LMB in SVR, including a 406-mm minimum size and two fish bag limit. These regulations should help to improve the size structure of the population. Minimum length limits are a commonly used restrictive regulation, and are generally implemented to protect the reproductive potential of fish populations, prevent overexploitation, increase angler catch rates, and promote predation on prey species (Noble and Jones 1993; Maceina et al. 1998; Iserman and Paukert 2010). By improving the LMB size structure, predation on Bluegills and Pumpkinseeds should increase, potentially improving the size structure of these species as well. However, the effects of the minimum size limit for LMB will take some time to become apparent due to the slower growth rates seen across most bass fisheries in Idaho compared to Midwestern and southeastern ecoregions (Bonar et al. 2009). Based on mean length-at-age data collected in 2012 by Hand et al. (2016a), Largemouth Bass in SVR reach 406 mm by age-8. This growth rate is actually one year faster than comparable population in the Northwestern Forested Mountain ecoregion, but two years slower than the national average (Bonar et al. 2009).

Although the lack of LMB >300 mm is concerning, it does not concern us from the standpoint of the water level drawdowns, as drawdowns are often used intentionally to manage fish populations. They can stimulate fish productivity by reestablishing conditions similar to when a reservoir was first filled (Miranda and Muncy 1987; Cooke et al. 2005). Other potential effects are increased predation on stunted prey populations, reduced predation on eggs by Centrarchids, and reduced competition for resources for young-of-year LMB (Heman et al. 1969; Miranda et al. 1984). The result can be improved sport fisheries through increased biomass and sizes of game fish, and a reduction in abundance of stunted Bluegill, crappie, or other planktivores. These effects of water level drawdown are likely contributing to the quality warm-water fishery found in Mann Lake (Hand et al. 2016a). If these drawdowns show similar positive effects in SVR, they may actually improve the fishery.

The creel surveys conducted in 2015 indicated that catch rates for hatchery RBT (0.9 fish/h) were above the management goal of 0.5 fish/h. This was similar to the 0.8 fish/h catch rate estimated in 2012 (Hand et al. 2016a). This suggests that the water drawdown is not having a substantial negative effect on catch rates. Additionally, with 63% of people interviewed rating their fishing experience as excellent or good compared to 57% in 2012, it appears that angler satisfaction was not affected either (Hand et al. 2016a). Throughout these public opinion surveys, only one person said anything negative regarding the water level. This was an angler who indicated that the low water level was the reason they rated their experience as “poor”. The public may have assumed that the low water was due to the natural annual drop in water level from reduced summer inflow and evaporation. Additionally, 2015 was an overly hot summer, which also likely contributed to the perception that the water level reduction was natural. We did have several comments/concerns submitted to the IDFG website regarding the water level. However, these comments all directed their concerns either at the Latah County Highway District for taking water from the reservoir for dust abatement, or just a general concern about the reduction in fish habitat. Therefore, we will need to continue monitoring angler satisfaction and potential concerns regarding the lower water levels over the next few years. Overall, the results of our angler surveys indicate that the water drawdown had no negative effect on catch rates or angler experience.

If the water releases into Spring Valley Creek are successful, this program may be implemented on a long-term basis, resulting in drawdowns annually in SVR. The primary issue that we foresee in the future regarding the water drawdown is reduced access to the reservoir from docks, the boat ramp, and shore that occurs due to the drawdown. The pictures in (Figure 28) illustrate these issues. The high angle on the walkways to the docks, and lack of water near shore could cause access problems for many anglers. Thus, there is concern that some people could stop going to the reservoir knowing the water levels are low. As we would not have the opportunity to interview these people, our surveys may have some inherent bias since the people we are interviewing could be less likely to have an issue with water levels. Another concern is impacts on non-angling recreational users of the reservoir. Lower water levels reveal large areas of mud and algae, which can reduce the visual appeal of the reservoir and cause odors that might be unappealing to some people (Figure 28). In 2012 and 2015, 36% and 58% of people recreating at SVR were not there to fish (Hand et al. 2016a). This shows that in many years, a large proportion of recreational usage at SVR does not involve fishing. If lower water levels turn these people away, there could be a larger than expected impact on the overall recreational usage of the reservoir.

With these issues in mind, we will need to be proactive with maintaining access to the reservoir. This could include minor projects such as developing ways to reduce the walkway angles, and adding stepped concrete fishing platforms that would allow access at a variety of water levels. It could also include major projects such as increasing the volume of water available in the top 1 - 2 meters of the water column. This would reduce the vertical drop incurred each year, and could be accomplished by actions such as dredging shallower areas or increasing the full pool elevation of the reservoir. Dredging can be prohibitively expensive, so increasing the elevation could be a cheaper alternative. These, and other potential alternatives, will require further research to develop the best option(s) based on available funding.

MANAGEMENT RECOMMENDATIONS

1. Conduct electrofishing, angler, and limnology surveys in 2016 to continue assessing the effects of water level drawdown on fish populations and angler satisfaction.

2. Implement a 406-mm minimum size limit and two fish bag limit for Largemouth Bass.

Table 4. Questions asked during angler opinion surveys at Spring Valley Reservoir, Idaho, in 2015.

1. Do you have a current hunting or fishing license?
2. What was your primary reason for visiting this lake today?
3. How would you rate your fishing experience today?
4. What species are you targeting today?
5. Give your top reason that led to the rating you gave for your fishing experience.

Table 5. Dissolved oxygen (D.O) and temperature profiles of Spring Valley Reservoir, Idaho, during 2015.

	8/4/2015		9/15/2015		10/7/2015		10/20/2015	
Depth	D.O	Temp	D.O	Temp	D.O	Temp	D.O	Temp
0m	9.9	23.0	9.5	16.8	10.2	15.0	7.3	14.3
1m	10.0	23.0	9.5	16.8	9.8	14.9	7.3	14.2
2m	10.1	23.0	9.5	16.8	8.4	14.5	7.2	14.0
3m	8.2	21.1	9.4	16.8	8.1	14.3	6.9	13.7
4m	1.5	19.2	0.1	15.5	8.2	14.2	6.9	13.4
5m	0.1	14.2	0.1	15.4	0.5	14.1	3.0	13.3
6m	0.1	11.8	0.1	11.0	0.7	14.0	1.5	13.2
7m	0.1	11.2	0.1	10.7			0.2	13.1

Table 6. Number of fish collected by species in each 10-minute electrofishing sample conducted during a standard lowland lake survey of Spring Valley Reservoir, Idaho, in 2015.

	Count of fish collected								
Species	EF Sample 1	EF Sample 2	EF Sample 3	EF Sample 4	EF Sample 5	EF Sample 6	Total	Mean	STDev
Largemouth Bass	23	31	27	25	27	34	167	27.8	4.0
*Other	48	47	59	40	88	88	370	61.7	21.3
Total	71	78	86	65	115	122	537	89.5	23.6

*Due to a data entry error, all other species were recorded as Bluegill.

Table 7. Summary of angler catch and harvest, by reporting type, for Spring Valley Reservoir, Idaho, during 2015.

	Number	Total	Rainbow Trout		Largemouth Bass		Black Crappie		Bluegill		Pumpkinseed		Other	
Interview type	of anglers	hours	Kept	Released	Kept	Released	Kept	Released	Kept	Released	Kept	Released	Kept	Released
In-person	130	271	54	98	7	36	0	2	4	22	1	2	0	0
Self report cards	111	312	226	134	20	97	0	0	0	0	0	0	0	5
Total	241	582	280	232	27	133	0	2	4	22	1	2	0	5

Date: ____________

Fishing Report Card

***** Please fill out one card for each angler, thank you.**

How long did you fish today: Start __________ End __________

Please circle type of fishing: **BANK** **BOAT** **FLOAT TUBE/PONTOON BOAT** **ICE**

Please circle method of fishing: **LURE** **BAIT** **FLY**

What was your targeted fish? **Trout** **Bass** **Crappie** **Bluegill** **Any Fish** **Other** ________

Please record the total number of fish released and kept in the spaces below:

Rainbow Trout		**Bass**		**Other** ________		**Other** ________	
Released	Kept	Released	Kept	Released	Kept	Released	Kept

Comments:

____

____

____

Reservoir: ______________________ Interview ID: ______________________

Figure 18. Voluntary angler survey report card used for angler surveys at Spring Valley Reservoir during 2015.

Figure 19. Volunteer angler survey card drop box and sign used for angler surveys at Spring Valley Reservoir in 2015.

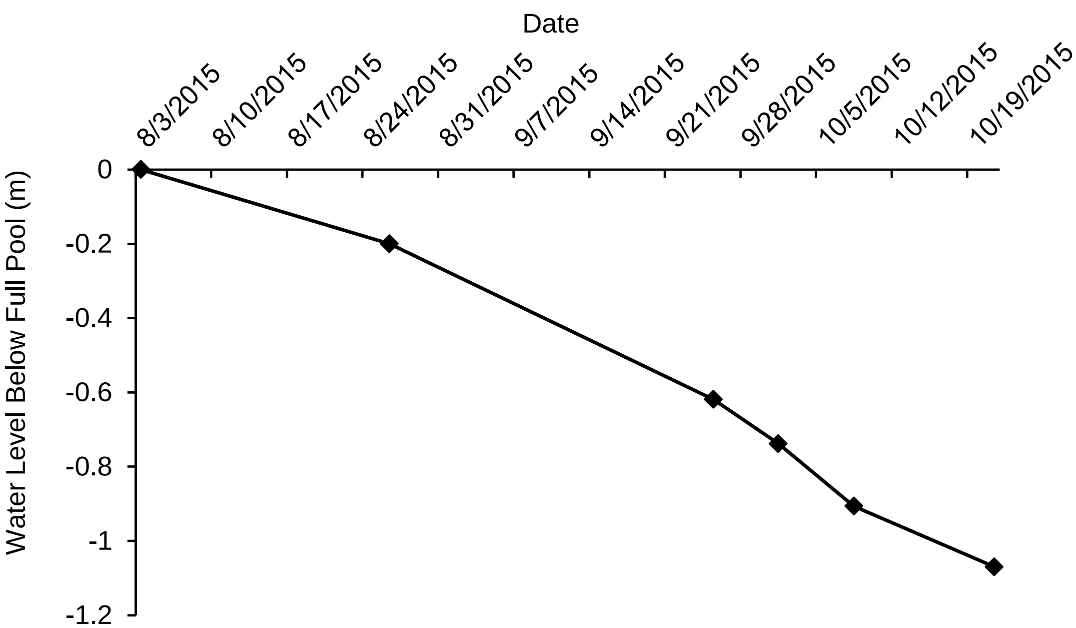

Figure 20. Water level of Spring Valley Reservoir, Idaho, during the water drawdown conducted from August 3 - October 21, 2015.

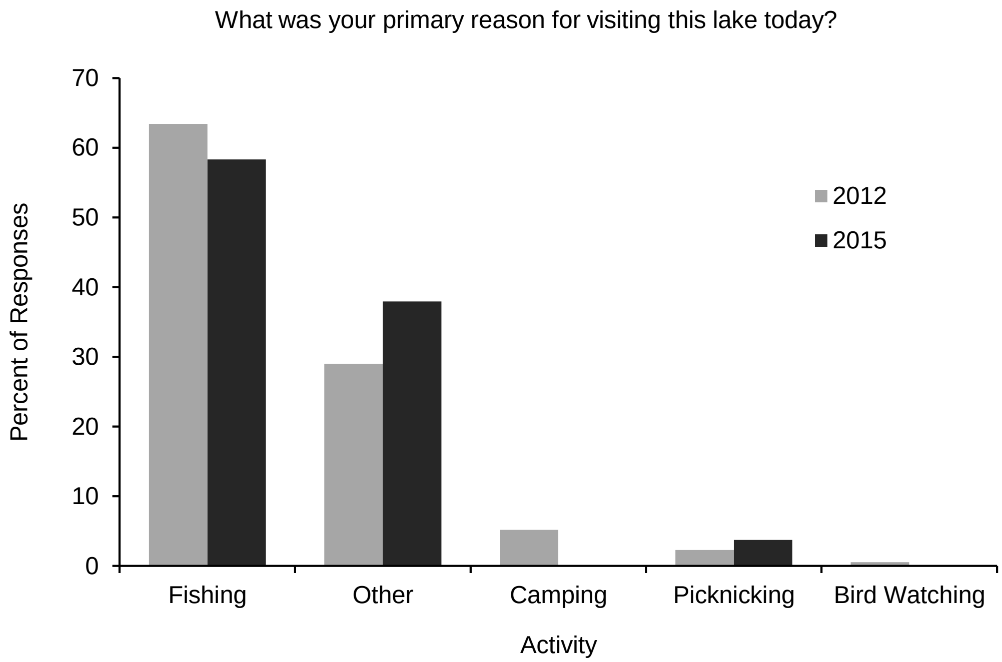

Figure 21. Comparison of angler responses to the primary reason for visiting Spring Valley Reservoir, Idaho, during creel surveys conducted in 2012 and 2015.

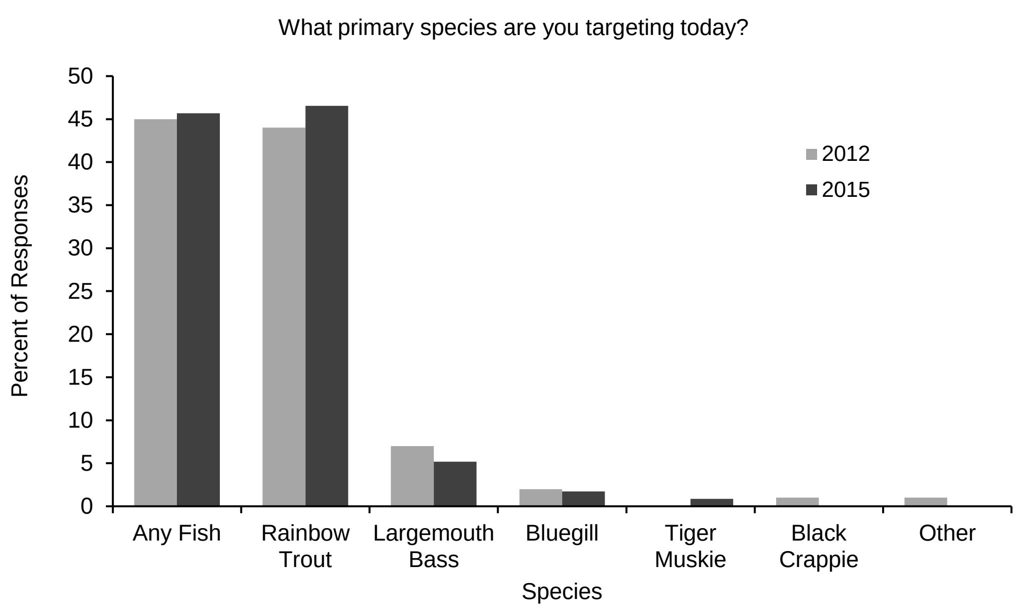

Figure 22. Comparison of angler responses regarding target fish species at Spring Valley Reservoir, Idaho, during creel surveys in 2012 and 2015.

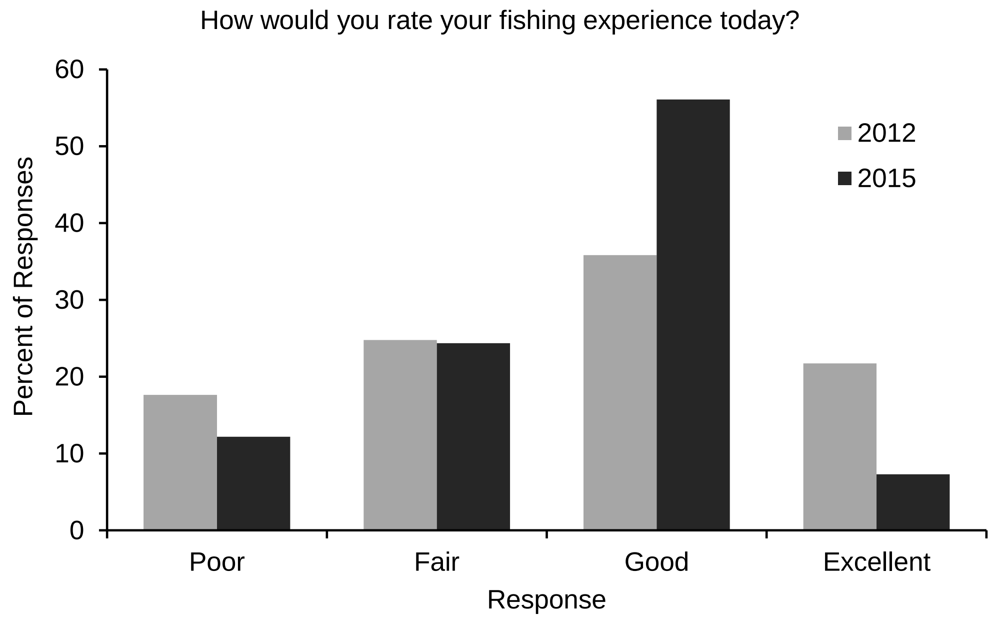

Figure 23. Comparison of angler responses regarding their overall fishing experience at Spring Valley Reservoir, Idaho, during creel surveys conducted in 2012 and 2015.

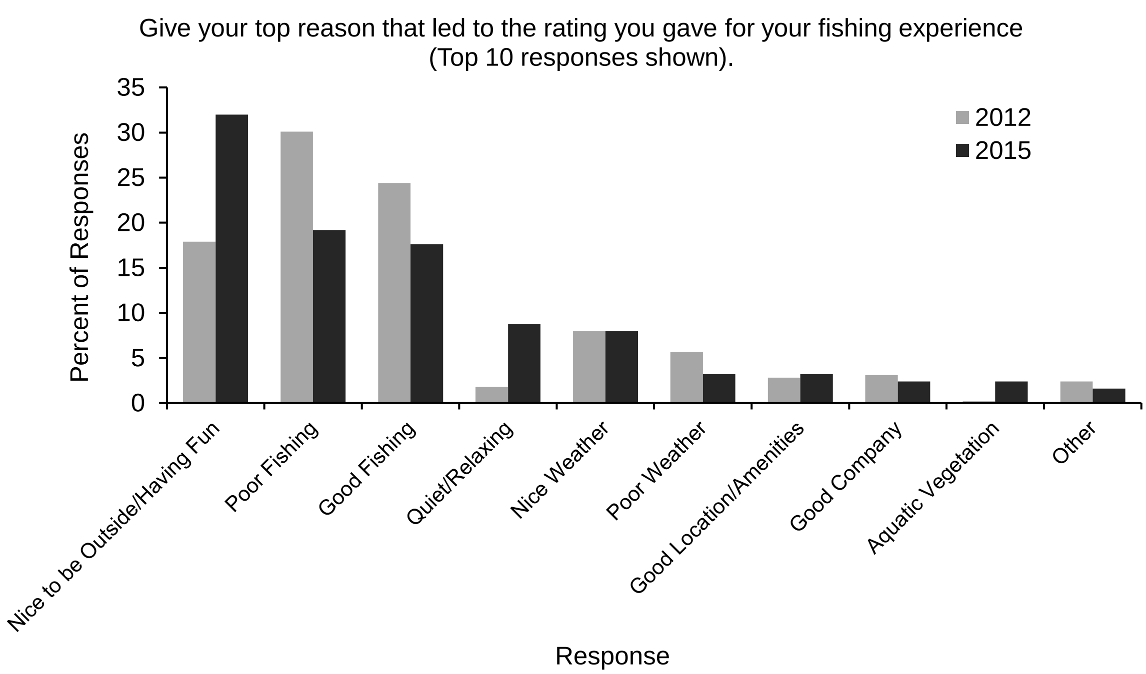

Figure 24. Comparison of the most common responses anglers provided for what influenced the quality of their experience when fishing at Spring Valley Reservoir, Idaho, as determined through creel surveys conducted in 2012 and 2015. (Ten most common answers shown).

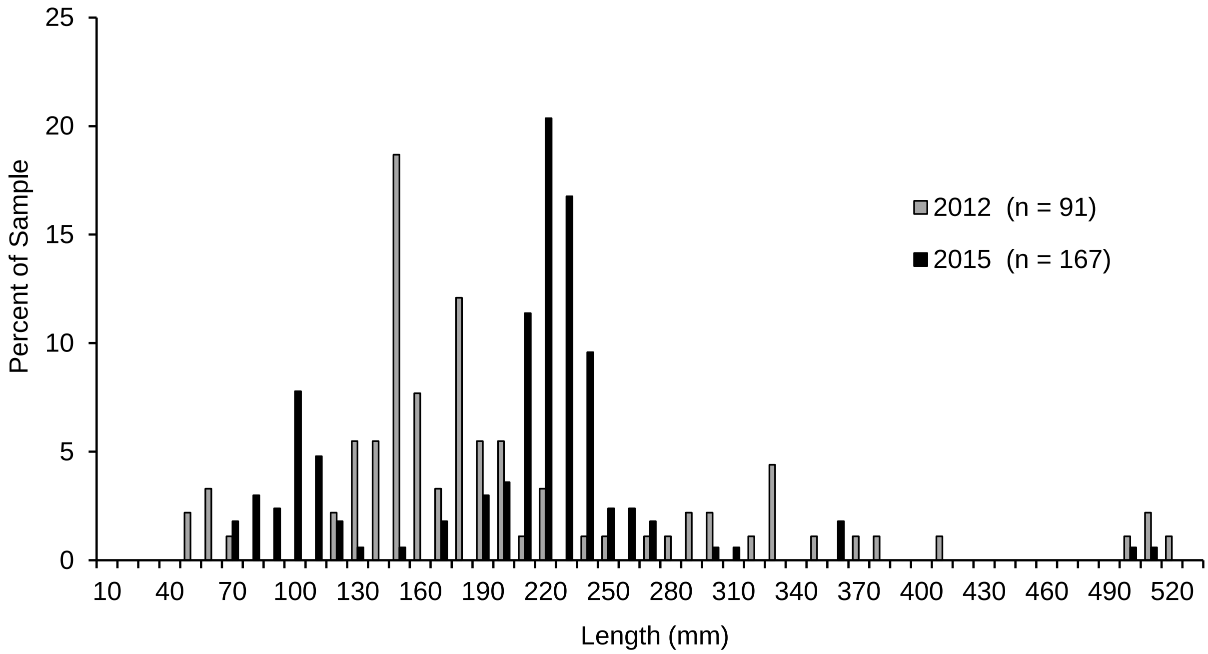

Figure 25. Comparison of Largemouth Bass length-frequency distributions from fish collected through electrofishing in Spring Valley Reservoir, Idaho, in 2012 and 2015.

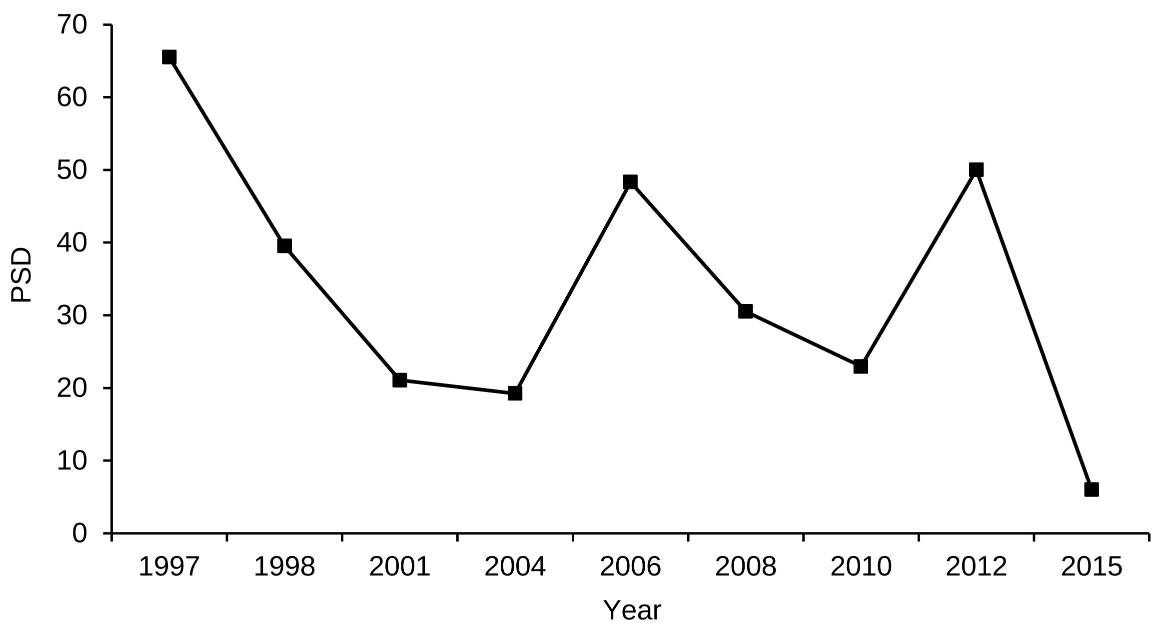

Figure 26. Proportional Size Distribution (PSD) values of Largemouth Bass collected through electrofishing in Spring Valley Reservoir, Idaho, from 1997 - 2015.

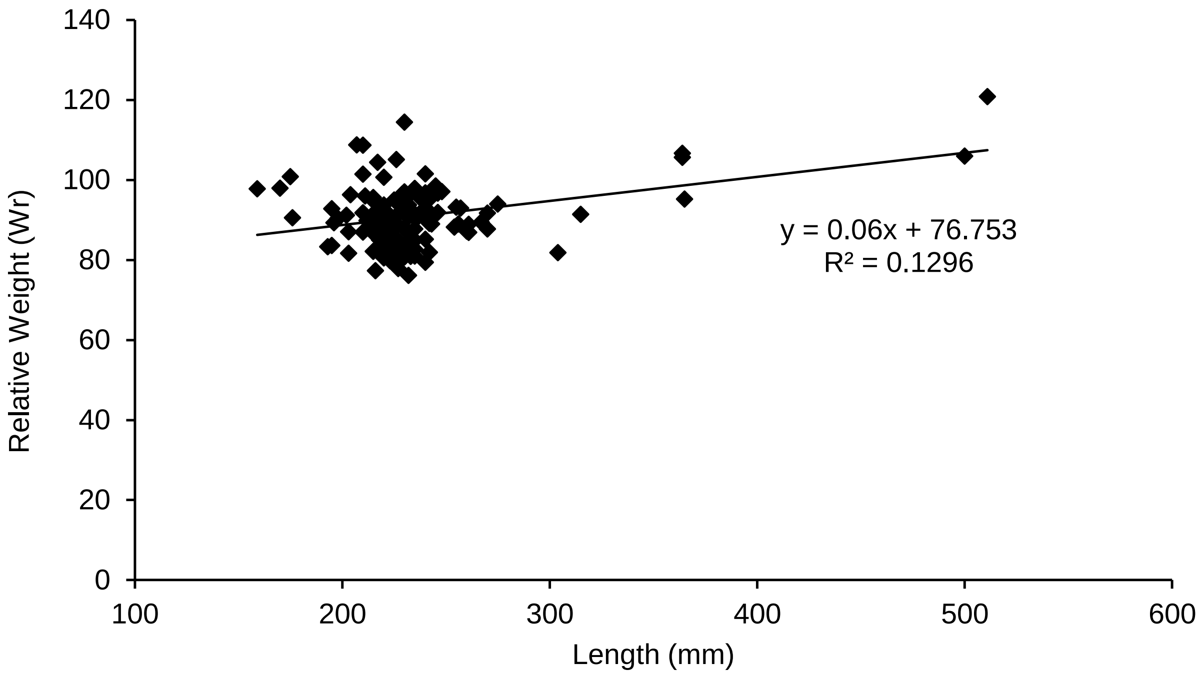

Figure 27. Relative weight values of Largemouth Bass (>150mm) collected through electrofishing in Spring Valley Reservoir, Idaho, in 2015.

Figure 28. Photos showing the effects of water level drop on Spring Valley Reservoir, Idaho, after water release conducted in 2015.

EVALUATION OF LARGEMOUTH BASS AND BLUEGILL IN WINCHESTER LAKE

ABSTRACT

An electrofishing survey was conducted on Winchester Lake in 2015 as follow-up to surveys conducted in 2012 and 2014. The results of the 2012 survey indicated that Largemouth Bass *Micropterus salmoides* and Bluegill *Lepomis macrochirus* size structure was declining. However, the 2014 sampling indicated that the Largemouth Bass population experienced a shift towards larger fish compared to 2012 which prompting additional sampling in 2015 to see if this trend continued. The data collected in 2015 continued to show a shift towards larger Largemouth Bass in comparison to the previous seven years. In fact, the average length (273 mm in 2015) of Largemouth Bass was the highest we've documented since this type of data was collected starting in 1997, and was 16 mm larger than the 2014 sample. This size shift is reflected by an increasing trend in PSD since 2010. In contrast, the Bluegill population continues to fluctuate. In 2015, average length and PSD increased from 2014, which were the lowest values calculated since 1997. The PSD is still within the range of 20 - 40 that indicates a balanced population. If the trend towards larger LMB continues, the fishery should be capable of producing quality-sized fish in the near future; although, this will be dependent on angler harvest rates of larger fish. Due to the continued improvement seen in the fishery, we do not recommend implementing any restrictive regulations.

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INTRODUCTION

In 2012, a fish population survey conducted on Winchester Lake indicated that the Largemouth Bass (LMB) *Micropterus salmoides* population was experiencing slow growth and cropping of larger individuals from harvest. This resulted in a population with few fish >304 mm. Additionally, anglers harvested no fish >300 mm during a 2012 creel survey. Based on information collected in 2012 and 2014, we considered the implementation of restrictive regulations such as a minimum size limit or protective slot limit. However, we decided it was important to conduct an additional population survey in 2015 to gather more information before making a decision to implement restrictive regulations on a family oriented fishery.

OBJECTIVES

1. Monitor length frequency distributions of sport fish in Winchester Lake.

STUDY AREA

Winchester Lake is located 0.8 km south of the town of Winchester, Idaho (

Figure 1). It is a 44.4-ha reservoir that lies at an elevation of 1,189 meters. It has a maximum depth of 9.8 m and a maximum volume of 1,500 acre-ft. It was created in 1910 by the damming of the headwaters of Lapwai Creek. It served as a mill pond by several lumber companies until it was drawn down in 1967 in order to install a new spillway and boat ramp (Moeller 1985). The City of Winchester discharged its municipal waste water into the lake until a new wastewater treatment facility was put into operation in 1972 (Moeller 1985). Today, the reservoir is characterized as highly eutrophic and prone to significant algal blooms and aquatic vegetation growth in the late summer. It is used extensively by boaters and fishermen, and is the focal point for the adjacent Winchester Lake State Park, which receives up to 37,000 visitors per year. Winchester Lake and its 3,159-ha watershed lie entirely within the Nez Perce Reservation. The watershed is used primarily for grazing, timber harvest, and recreation.

METHODS

A fish survey of Winchester Lake was conducted on May 20, 2015. Six, 10-minute electrofishing periods were conducted on the reservoir for a total of 3,600 sec. of electrofishing effort. The methodology used to survey this fish community is presented in the Deyo Reservoir Investigations section of this report. For the purposes of this survey, only Bluegill *Lepomis macrochirus* and LMB were collected.

RESULTS

The electrofishing resulted in the capture of 578 fish including Bluegill (n = 455) and LMB (n = 123; Figure 29). The LMB CPUE (123 fish/h) was similar to that seen in recent years (Figure 29). Largemouth Bass collected ranged from 150 - 390 mm in length (Figure 30), with an average length of 273 mm (Figure 31). Sixty-two of the 123 fish collected (50.4%) were over 300 mm in length. The ten surveys (started in 1997) prior to this one found that on average of 13.1% of fish were >300 mm. Largemouth Bass PSD was 65 (Figure 32) in 2015, the third consecutive increase since 2010 and the highest since this data started being collected in 1997.

Bluegill CPUE (455 fish/h) was the second highest for all surveys conducted since 2000 (Figure 29). Bluegill collected in 2015 ranged from 35 - 210 mm in length (Figure 33), with an average of 136 mm (Figure 31). This average size was longer than what was documented in 2014, but it was still the second lowest we have observed since 1997. The PSD of 34 in 2015 was the same as 2014, which is the lowest we have documented since this trend data set began in 2017 (Figure 32).

DISCUSSION

The results of a fishery survey conducted in 2012 indicated that LMB and Bluegill size structure was declining due to slow growth and harvest of larger fish (Hand et al. 2016a). This resulted in a population with few LMB >300 mm and harvest of fish <300 mm by anglers. Data collected in 2014 and 2015, however, has indicated that the LMB population is experiencing an improvement in both average length and PSD (Figure 31 and Figure 32). In fact, the average length of 273 mm in 2015 was the highest of any sample since 1997. In contrast, the Bluegill population continues to fluctuate. While average lengths have remained fairly constant over time, PSD values have shown a cyclical pattern of rising and falling since 1997 (Figure 31 and Figure 32).

A comparison of PSD values for both LMB and Bluegill can provide insight into potential population issues (Schramm and Willis 2012). In Winchester Lake, nine of the ten years of sampling prior to 2015 occurred either in Cell 1 or Cell 4 of the predator: prey relationship chart (Figure 34). In both 2012 and 2014, this relationship was located in Cell 4. However, in 2015, this relationship shifted to Cell 6 for the first time. This cell is generally indicative of a high-quality LMB population. However, the lack of quality-size LMB in Winchester Lake does not suggest that the fishery would be considered high-quality. If the LMB population continues this current trend towards larger fish, the fishery should produce quality-sized fish in the near future; although, this will be dependent on angler harvest rates of larger fish.

It is interesting to point out the cyclic nature of both the Largemouth Bass and Bluegill populations based on PSD values that has occurred since at least 1997 (Figure 32). These cyclic fluctuations can be due to a variety of factors such as survival/mortality rates, variable recruitment, density dependence, predator-prey dynamics, and environmental factors such as weather/climate (Nisbet and Gurney 1982; Sanderson et al. 1999). In Winchester Lake, these cycles are likely a combination of predator-prey dynamics, variable recruitment, and harvest. Predator-prey PSD values exhibit classic “boom or bust” characteristics, with increases in predator PSD coupled with declines in prey PSD, and vice versa. We will likely continue to see this cycle in Winchester Lake unless changes are made to the management of this reservoir. Normally, we would recommend implementing restrictive regulations to improve the LMB and Bluegill populations. However, due to the presence of Winchester State Park, and popularity of the reservoir with families and children, Winchester Lake is managed as a “family friendly fishing water.” In order to maintain this management strategy, and due to the continued improvement seen in the fishery, we do not recommend implementing any restrictive regulations. Additionally, we recommend discontinuing annual surveys, and returning to the standard three-year survey cycle.

MANAGEMENT RECOMMENDATIONS

1. Return to monitoring fish populations in Winchester Lake on the standard three year cycle.
2. Do not implement restrictive regulations on Largemouth Bass.

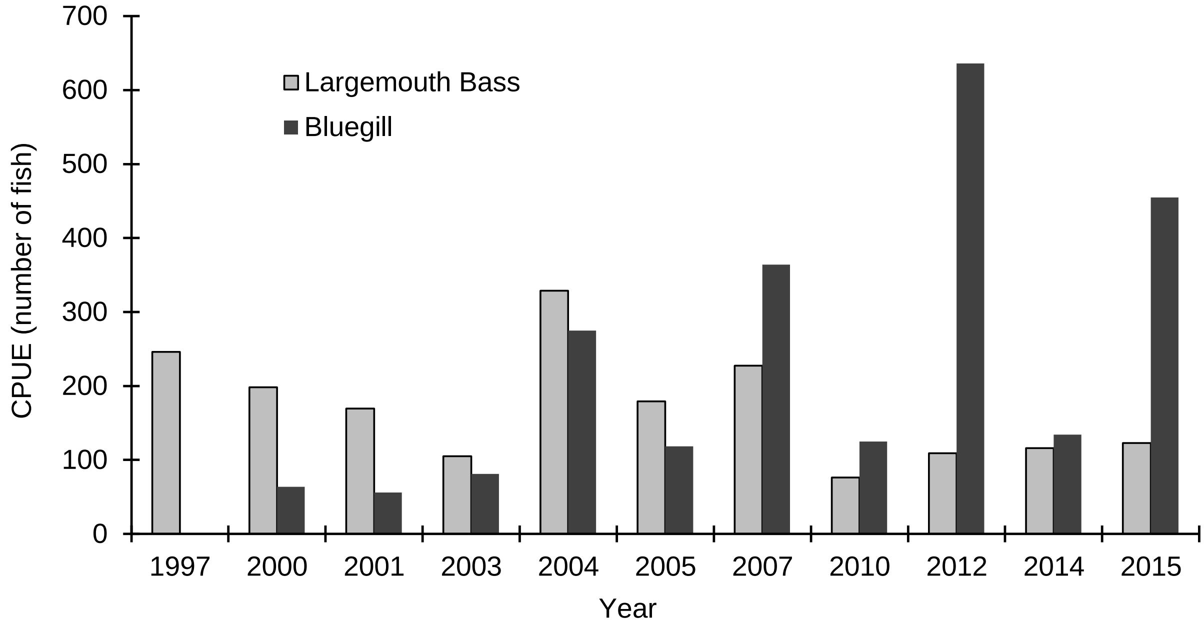

Figure 29. Catch per unit effort (CPUE; number of fish/hour) of Largemouth Bass and Bluegill sampled during electrofishing surveys of Winchester Lake, Idaho, from 1997 - 2015.

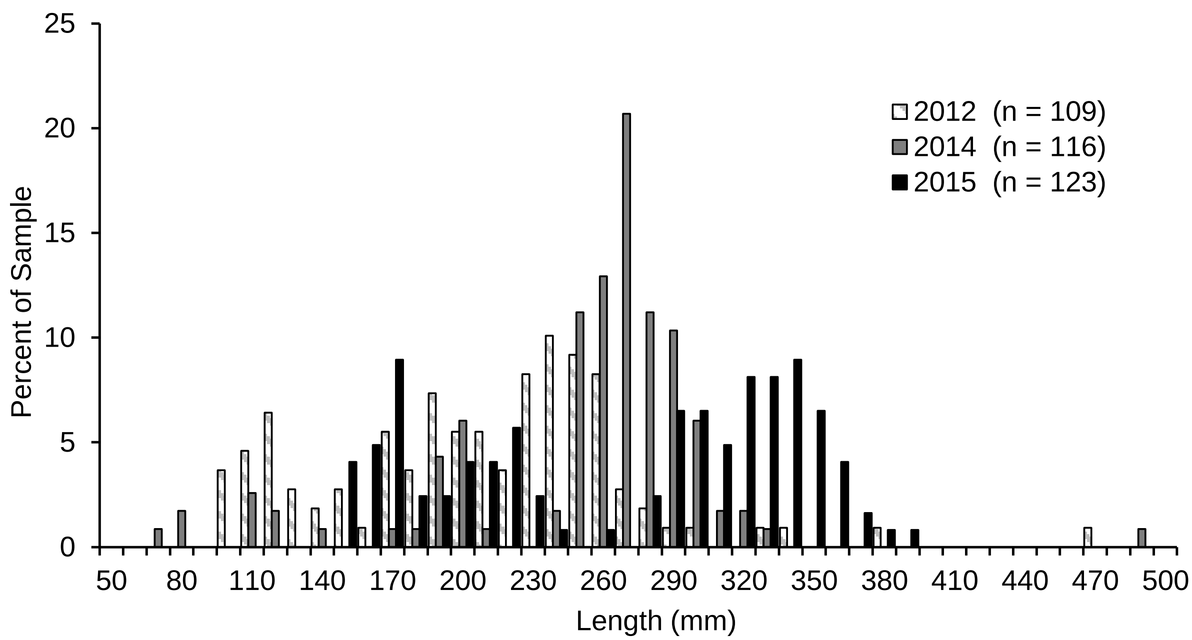

Figure 30. Length-frequency distribution of Largemouth Bass collected during electrofishing surveys of Winchester Lake, Idaho, in 2012, 2014, and 2015.

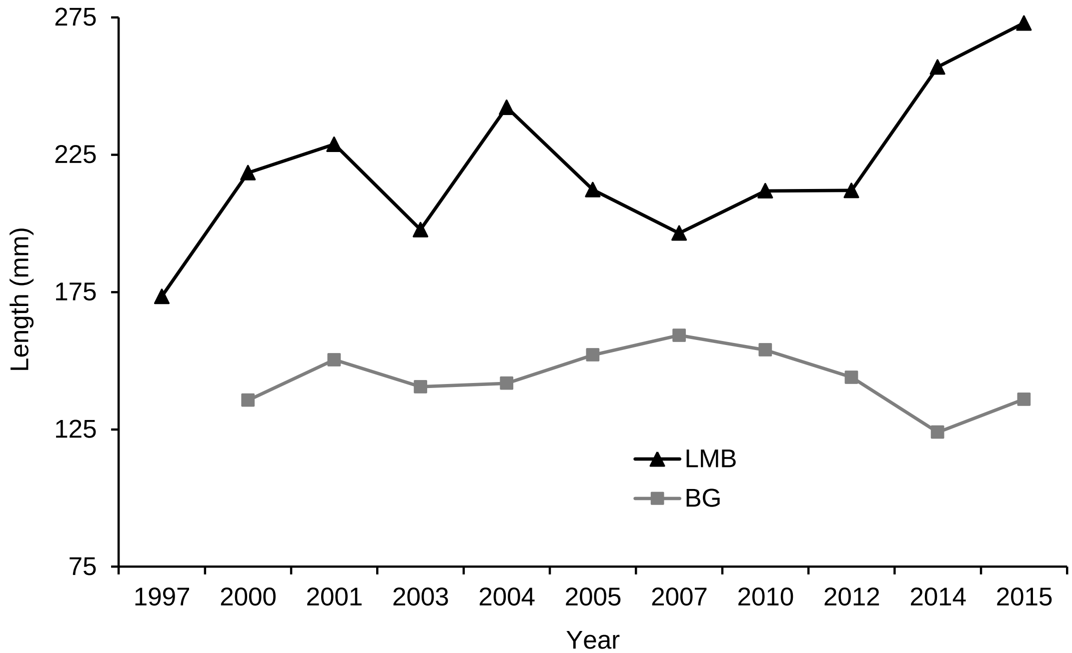

Figure 31. Average length of Largemouth Bass and Bluegill collected by boat electrofishing from Winchester Lake, Idaho, from 1997 - 2015.

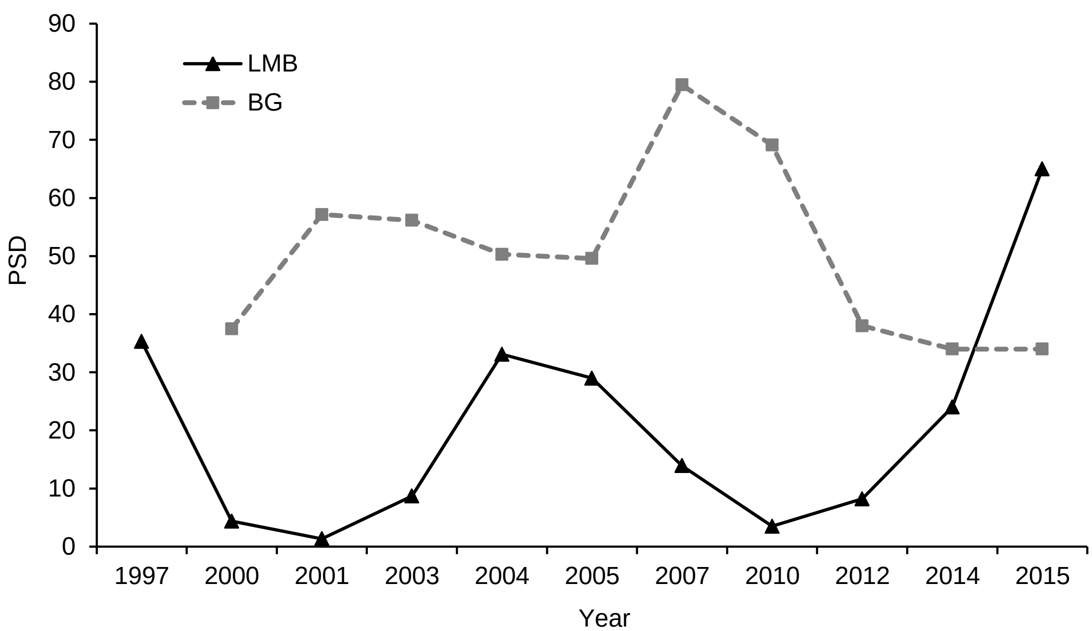

Figure 32. Proportional Size Distribution (PSD) values of Largemouth Bass and Bluegill collected through electrofishing in Winchester Lake, Idaho, from 1997 - 2015.

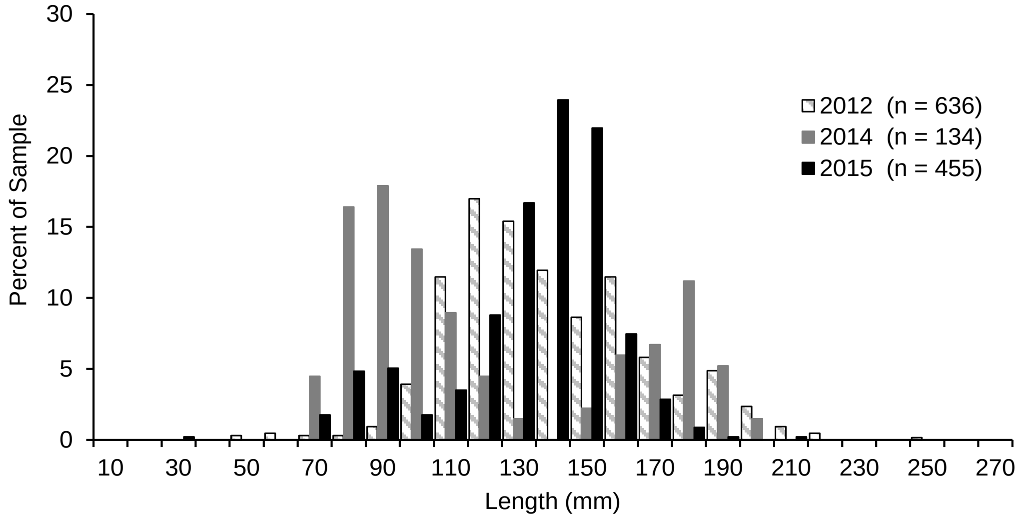

Figure 33. Length-frequency distributions of Bluegill collected by boat electrofishing in Winchester Lake, Idaho, in 2012, 2014, and 2015.

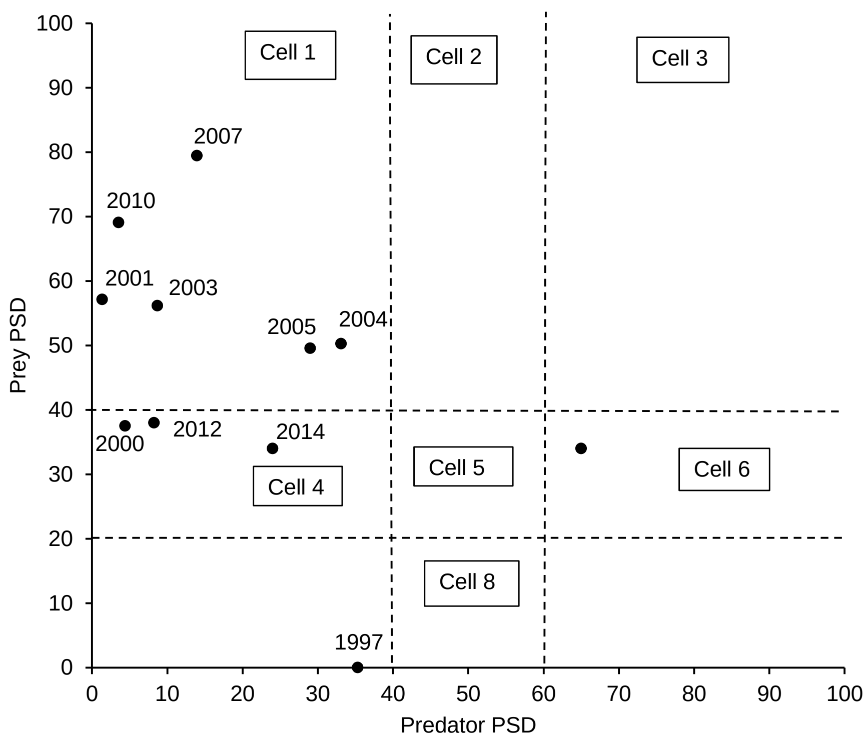

Figure 34. Comparison of predator (Largemouth Bass) and prey (Bluegill) proportional size distribution (PSD) at determined through electrofishing surveys conducted in Winchester Lake Idaho, from 1997 - 2015. Dashed lines define the nine predator:prey PSD size structure possibilities based on Schramm and Willis (2012).

SCHMIDT CREEK MONITORING

ABSTRACT

To assess whether the construction of Deyo Reservoir is negatively influencing downstream steelhead *Oncorhynchus mykiss* habitat, stream flow, temperature, conductivity, and dissolved oxygen (DO) was monitored in Schmidt Creek. Average daily water temperature across the sampling season was 13.4°C, while maximum daily water temperatures exceeded 20°C for six days. Average monthly DO measured on Schmidt Creek was 9.0 mg/L during the sampling season, and ranged from a low of 6.2 mg/l in September to a high of 10.7 mg/L in April. Conductivity during 2014 ranged from 112 - 174 µS/m, and stream flow ranged from a high of 0.0198 m^3/s (0.7 cfs) in April to a low of 0.0011 m^3/s (0.04 cfs) in August. Summer flows have not changed since monitoring began in 2011. In fact, due to natural seepage through the dam, the flow below the reservoir has changed from intermittent to perennial. Deyo Reservoir may therefore be helping to solve the major limiting factor for steelhead in Schmidt Creek (summer low flows). Additionally, DO concentrations in Schmidt Creek have remained above 6 mg/L throughout the monitoring season each year since monitoring began in 2011. Maximum daily water temperatures in Schmidt Creek continue to be highly variable but remain well below lethal limits for steelhead during most of the year. Thus, monitoring conducted since 2011 indicates that the environmental parameters that could influence steelhead survival in Schmidt Creek are not detrimental to steelhead. Monitoring will continue through 2016.

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INTRODUCTION

The Idaho Department of Fish and Game (IDFG), in conjunction with support from local communities, constructed a 22.3-ha reservoir on Schmidt Creek near Weippe, Idaho, in 2012. Named Deyo Reservoir, its purpose was to provide a new recreational fishery and an economic boost to the local economy (DuPont 2011).

Fish surveys in upland reaches of Schmidt Creek in close proximity to the reservoir observed Long-nose Dace, *Rhinichthys cataractae,* as the only native species in that area. Fish species distributed in lower Schmidt Creek include Rainbow Trout/steelhead *Oncorhynchus mykiss*, sculpin sp., and dace (DuPont 2011). Surveys conducted on Schmidt Creek by IDEQ in 2002, within 60 m of the mouth of the creek, also collected *O. mykiss*. Given the presence of *O. mykiss* in lower Schmidt Creek, it is important to monitor the lower reaches to ensure no detrimental effects occur downstream of the dam. An agreement was made with the U.S. Fish and Wildlife Service to monitor outflow of the Deyo Reservoir project area pre- and post-construction to ensure no deleterious effects occur in downstream habitats below the reservoir (DuPont 2011). If deleterious effects occur, IDFG will modify water release strategies as needed.

OBJECTIVES

1. Monitor flow, temperature, dissolved oxygen (DO), and conductivity in Schmidt Creek to ensure construction of Deyo Reservoir is not having negative impacts on steelhead downstream.

STUDY AREA

Deyo Reservoir is located on Schmidt Creek, a tributary to Lolo Creek, Idaho (Figure 35). Schmidt Creek contains designated critical habitat for steelhead from its mouth to 1.1 km upstream. The end of steelhead critical habitat is 2.7 km below the Deyo Reservoir Dam site. Prior to construction of Deyo Reservoir, stream flow within Schmidt Creek was considered intermittent within the reservoir project area and potentially perennial in lower reaches depending on annual precipitation within the drainage area.

METHODS

Schmidt Creek was monitored in 2015 for stream temperature, dissolved oxygen, conductivity, and flow at a monitoring location approximately 50 m upstream from its confluence with Lolo Creek. Temperature was recorded hourly in °C using a HOBO™ temperature logger. Dissolved oxygen and conductivity were recorded bi-weekly using a YSI model 550A meter. Stream flow was recorded bi-weekly using an OTT MF Pro flow meter. Data was collected from April 27^{th} - November 10^{th}, 2015.

RESULTS

Average daily water temperature at the Schmidt Creek monitoring station was 13.4°C in 2015, higher than the average of 12.9°C in 2014 and 11.3°C in 2013. Maximum daily water temperature exceeded 20.0°C on six days during 2015, peaking at 20.3°C on July 17^{th} (Figure 36). Average monthly DO measured on Schmidt Creek was 8.9 mg/L during the 2015 sampling season. Dissolved oxygen levels ranged from a low of 6.2 mg/l in July to a high of 10.7 mg/l in November (Figure 37). Dissolved oxygen levels were above 6.0 mg/L for the entire sample season, and were within the ranges seen in sampling conducted from 2011 - 2014. Conductivity in Schmidt Creek during 2015 ranged from 112 - 174 µS/m (Figure 38). The monthly averages were higher than seen in 2014, but followed the same pattern seen in sampling conducted since 2011.

Stream flow at the Schmidt Creek monitoring station ranged from a high of 0.0198 m^3/s (0.7 cfs) in November to a low of 0.0011 m^3/s (0.04 cfs) in July (Figure 39). Flow did remain visible throughout the 2015 sample season. Flow rates in 2015 were similar to what was seen in 2014. No de-watering of the stream channel has been observed since sampling began in 2011.

DISCUSSION

Due to the construction of Deyo Reservoir during the summer of 2011, there was concern that potential changes in flow, DO, and temperature could have deleterious effects on environmental parameters measured downstream in Schmidt Creek. Due to the presence of steelhead in the lower reaches of the creek, flow is the most important variable for us to monitor downstream of the reservoir. Summer flows have not changed since monitoring began in 2012 (Figure 39). Based on visual observations, natural seepage through the dam has changed flow below the reservoir from intermittent to perennial. Deyo Reservoir may therefore be mitigating the major limiting factor for steelhead in Schmidt Creek (summer low flows).

Additionally, dissolved oxygen concentrations in Schmidt Creek have remained above 6 mg/L throughout the monitoring season each year since monitoring began in 2011 (Figure 37). Average and maximum water temperatures have not appeared to change over the duration of this study. Studies have shown Rainbow Trout/steelhead avoid temperatures in the mid 20 ^oC (Neilsen et al. 1994 and Matthews and Berg 1997) but temperatures at or near 20 ^oC are not detrimental, especially for short periods of time. Maximum daily water temperatures in Schmidt Creek continue to be highly variable but still remain well below lethal limits for Rainbow Trout/Steelhead during most of the year. In 2011 and 2014, water temperatures never exceeded 20 ^oC (Figure 36). Maximum daily water temperatures exceed 20˚C for only seven days in 2012, four days in 2013, and six days in 2015.

Thus, monitoring conducted since 2011 indicates that the environmental parameters (flow, DO, temperature) that could influence steelhead survival in Schmidt Creek are not detrimental. In 2016, we will continue to monitor the site with bi-monthly field visits that will include DO, conductivity, and stream flow measurements. In addition, we will deploy a HOBO™ temperature logger to provide continuous temperature monitoring data. We also recommend adding a sample site immediately below the reservoir to compare stream conditions to the downstream site.

MANAGEMENT RECOMMENDATIONS

1. Continue to monitor Schmidt Creek through 2016.

2. Add monitoring site immediately below dam to allow for comparisons between the two sites.

Figure 35. Map showing location of Deyo Reservoir, Idaho, and the Schmidt Creek monitoring station.

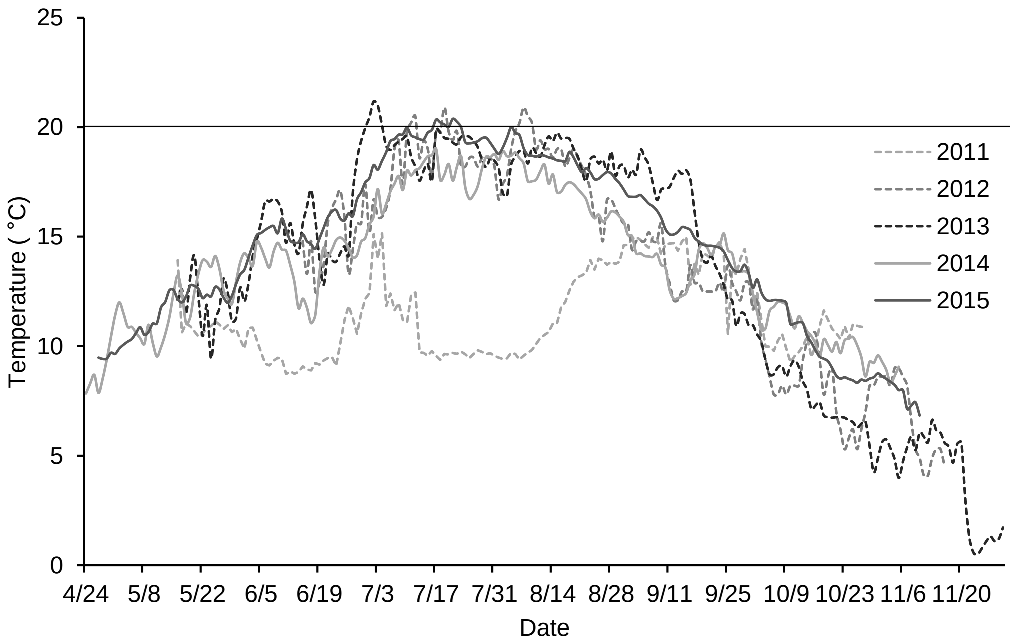

Figure 36. Daily maximum water temperatures measured at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) from 2011 - 2015 (20°C is indicated by horizontal line).

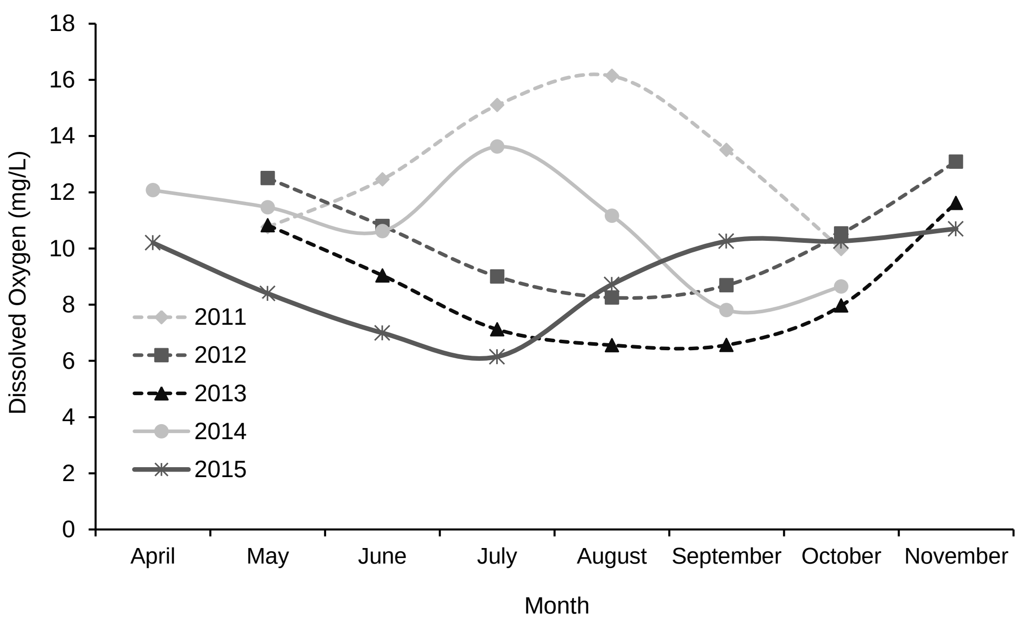

Figure 37. Average monthly dissolved oxygen levels at the Schmidt Creek, Idaho, monitoring Station (N 46.355800°, W -116.052637°) from 2011 - 2015.

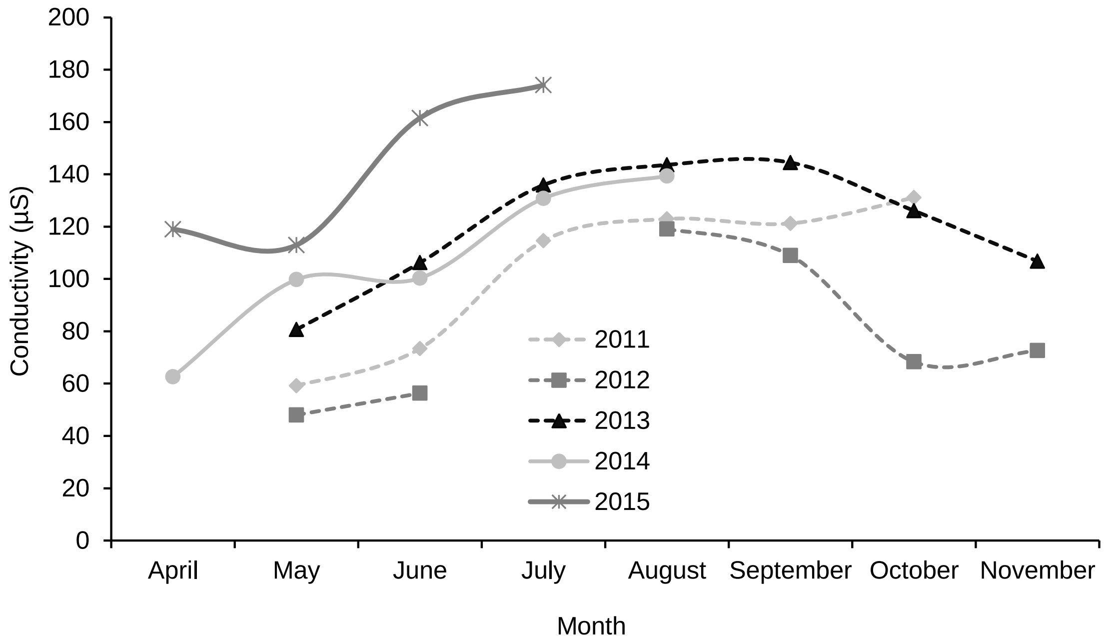

Figure 38. Average monthly conductivity readings at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) from 2011 - 2015.

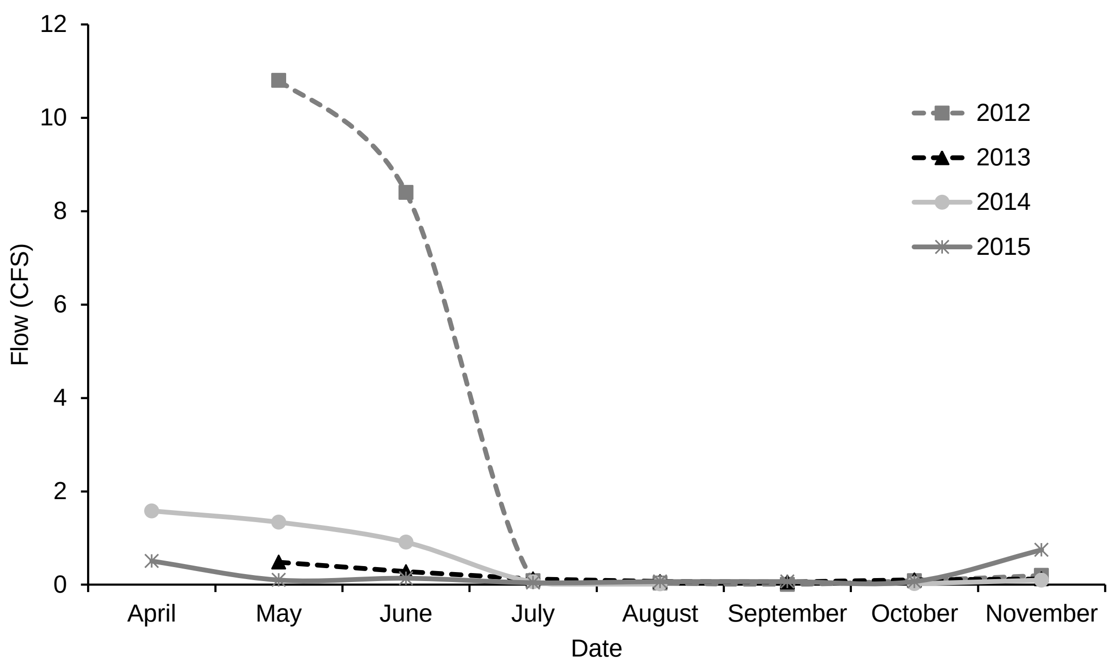

Figure 39. Average monthly flow (cfs; cubic feet per second) at the Schmidt Creek, Idaho, monitoring station (N 46.355800°, W -116.052637°) from 2012 - 2015.

HIGH MOUNTAIN LAKES MONITORING: AMPHIBIAN RISK ASSESSMENT IN NORTH CENTRAL IDAHO

ABSTRACT

A 20-year study was designed in 2006 to evaluate long-term trends in amphibian populations within high mountain lakes in the Idaho Department of Fish and Game Clearwater Region and to determine the extent that fish stocking has influenced amphibian persistence. Mountain lake surveys prior to 2006 provided baseline information on amphibian and fish abundance and distribution and were utilized to develop an amphibian risk assessment based on the amount of fishless lakes and ponds within fifth field hydrologic unit code (HUC 5) watersheds throughout the Clearwater Region. In 2015, we conducted our tenth year of the long-term monitoring project. Surveys were completed on 33 lakes, including multiple amphibian surveys on a subset of 20 lakes. All 74 lakes included in this study have now been surveyed twice. In the first round of sampling, 63 of 74 lakes (85.1%) had Columbia Spotted Frogs (CSF) *Rana luteiventris* present. Of these, 23 lakes had fish present and 40 did not have fish present. Additionally, 37 of 74 lakes (50%) had Long-toed Salamanders LTS) *Ambystoma macrodactylum* present. Of these, 7 lakes had fish present and 30 did not have fish present. Data analysis in 2015 repeated the distribution and trend models from 2013, and calculated detection probabilities on a subset of lakes that were surveyed multiple times. Detection probability for CSF in this subset appeared to approach 1.00, and for LTS was 0.57 with the lakes that were sampled twice in the season. Habitat relationships for both LTS and CSF were generally consistent with the 2014 analysis. For CSF, the depth and proportion of fine substrates in a lake were positively correlated with both occurrence and count. Snowpack significantly correlated with CSF count, though the relationship is probably not causative. Long-toed Salamander occurrence and count were significantly influenced by fish presence. This is likely attributable to the longer larval stage of LTS (relative to CSF) and increased susceptibility to predation during this aquatic life stage. Several habitat variables also seemed to drive LTS counts, but this may model detection as much as abundance. Preliminary results show no significant trends in amphibian occurrence in the study area. We did detect a significant positive trend in counts, but these results may indicate some sampling bias and not a true population increase. Once additional rounds of surveys are completed, we can be more confident of any trends in the data.

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INTRODUCTION

Declining amphibian populations and species extinction has given urgency to amphibian conservation, inventory efforts to determine baseline data, and monitoring to determine trends in amphibian populations (Houlahan et al. 2000; Stuart et al. 2004; Beebee and Griffiths 2005; Orizaola and Brana 2006). Potential factors in amphibian population decline are numerous and include: habitat modification/fragmentation, introduction of predators/competitors, increased UV-B radiation, changes in precipitation/snowpack, and pathogen infection (Alford and Richards 1999; Corn 2000; Pilliod and Peterson 2000; Marsh and Trenham 2001). Throughout the north-central mountains of Idaho, direct (predation) and indirect impacts (resource competition, habitat exclusion, and population fragmentation) on amphibian populations from introductions of trout into historically fishless lakes are a cause for concern (Petranka 1983; Semlitsch 1988; Bradford 1989; Figiel and Semlitsch 1990; Bradford et al. 1993; Brönmark and Edenhamn 1994; Gulve 1994; Brãna et al. 1996; Tyler et al. 1998). Trout have been stocked into high mountain lakes to provide recreational opportunities to backcountry visitors. As much as 95% of previously and/or currently stocked high mountain lakes throughout the western United States that were once fishless, now contain fish through regular stocking efforts or self-sustaining populations from legacy stocking efforts (Bahls 1992). Murphy (2002) estimated that 96% of lakes within the Clearwater National Forest were historically fishless, as the headwater area topography where lakes are located is relatively steep. According to historical stocking records, some lakes in north-central Idaho were stocked as early as the 1930s (Murphy 2002). Out of the estimated 3,000 mountain lakes in Idaho, approximately 1,355 lakes (45%) are stocked or have natural fish populations (IDFG 2012)

Mountain lake ecosystems in North Central Idaho contain amphibians such as Long-toed Salamanders (LTS) *Ambystoma macrodactylum* and Columbia Spotted Frogs (CSF) *Rana luteiventris*, although Idaho Giant Salamanders *Dicamptodon aterrimus*, Western Toads *Bufo boreas*, and Rocky Mountain Tailed Frogs *Ascaphus montanus* may also be present. Common reptiles found at these mountain lakes may also include Common Garter Snakes *Thamnophis sirtalis* and Western Terrestrial Garter Snakes *T. elegans*, both of which were historically (before fish introductions) the main amphibian predators (Murphy 2002). The Idaho Department of Fish and Game (IDFG) Clearwater Region contains 711 mountain lakes. Approximately 400 of these mountain lakes were previously inventoried in the Clearwater Region through cooperation between the IDFG and United States Forest Service (USFS).

Murphy (2002) found that CSF presence (and breeding occurrence) in this area was not significantly different in lakes with or without fish after accounting for habitat effects (CSF were positively associated with increasing amounts of sedge meadow perimeter and silt/organic substrate). However, CSF abundance at all life stages was significantly lower in lakes with fish than without fish (Murphy 2002). Long-toed Salamander larvae and/or breeding adult presence and abundance (adults are typically terrestrial except to breed) was significantly less common in lakes with fish then lakes without fish (Murphy 2002). However, where native (not stocked) Westslope Cutthroat Trout (WCT) *Oncorhynchus clarkii lewisi* existed in lakes, the impact on LTS was not as severe as compared to lakes that were historically fishless and later stocked with introduced western trout (Murphy 2002). Other studies have examined relationships between introduced trout and salamanders. Direct negative impacts by fish on amphibian populations have been mostly attributed to trout preying upon amphibians when they are at a larval stage, although trout may also cause salamanders to avoid lakes previously used as breeding sites (indirect impact; Kats et al. 1993; Figiel and Semlitsch 1990; Bradford et al. 1993; Knapp 1996; Pilliod 1996; Graham and Powell 1999; Murphy 2002).

Introduced fish populations may also indirectly impact amphibian gene flow, recolonization, and subsequent persistence. The degree of gene flow in mountain lake amphibian populations likely relies on connectivity between higher and lower elevation subpopulations (with low gene flow). Gene flow may also occur between neighboring lakes that are not necessarily within the same wet stream migration corridor when overland dispersal is not drastically limited by headwater topography, precipitation, and or canopy cover (Murphy 2002). Tallmon et al. (2000) suggests that LTS within north-central Idaho are panmictic (randomly interbreeding populations) with high levels of within population variation providing evidence that populations are not evolving in complete isolation. Amphibian populations, or demes, in these headwater areas likely never evolved with native fish and may lack the appropriate defensive, behavioral, or chemical responses to coexist with introduced fish populations (Kats et al. 1988).

Westslope Cutthroat Trout, Rainbow Trout (RBT) *O. mykiss*, RBT x WCT hybrids, and Brook Trout (BKT) *Salvelinus fontinalis* are the most common introduced fish species in high mountain lakes in the Clearwater Region. Additionally, many lakes within the study area have a stocking history that may include Yellowstone Cutthroat Trout *O. bouvieri*, California Golden Trout *O. mykiss aguabonita* (last stocked in 1990 in the Clearwater Region - Steep Lakes), Arctic Grayling *Thymallus arcticus* (last stocked in 1982 in the Clearwater Region - Bald Mountain Lake), and various forms of trout hybrids. The term “introduced western trout” may be more appropriate for *Oncorhynchus* species in these lakes where natural reproduction is occurring, as the degree of hybridization is unknown in lakes where multiple species have been stocked (Behnke 1992). The Clearwater Region currently stocks 87 of its 711 high mountain lakes. Most lakes are stocked with fingerling WCT on a three-year rotation using fixed-wing aircraft.

Murphy (2002) also found that certain species of introduced trout tend to have a greater impact on amphibian occupancy than others. Brook Trout tend to impact CSF and especially LTS presence and breeding to a greater extent than the presence of either *Oncorhynchus* species. This impact is believed to be derived from differences in fish spawning times/behavior and variations in amphibian habitat usage just after ice-off conditions in mountain lakes (Murphy 2002). Westslope Cutthroat Trout and RBT in these lakes spawn in spring/summer which often coincides with times that amphibian breeding occurs. As a result, both fish species are typically preoccupied with spawning in inlets or outlets while amphibians are typically breeding within the lake itself. This difference in spawning habitat use may allow amphibians to breed with fewer disturbances by WCT and RBT (Murphy 2002). In contrast, BKT spawn in the fall and are actively moving and foraging throughout the lake in spring and are more likely to prey upon any amphibian life stage and/or harass breeding adults (Murphy 2002). Furthermore, BKT tend to be more benthic oriented (where salamanders usually occur), seek out larger prey items, and attain higher densities within mountain lakes than *Oncorhynchus* species (Griffith 1974). Columbia Spotted Frogs do not tend to be impacted by BKT presence to the same magnitude as LTS because of their different habitat associations and shorter larval stage.

Long-toed Salamanders occupy a wide range over the western United States and Canada. The majority of LTS in Idaho sub-alpine lakes have a two-year larval stage, making them susceptible to predation by fish for a longer period of time. Studies suggest that they are more susceptible to impacts by introduced fish than the CSF (Murphy 2002). However, conclusive evidence of LTS decline is insufficient (Graham and Powell 1999). For this reason, a long-term monitoring project (20 years) was initiated in the Clearwater Region to provide knowledge of the amphibian population dynamics within the north-central mountains of Idaho. Long-term monitoring of mountain lakes will allow for amphibian population trends to be identified and will give managers the ability to determine whether sufficient fishless habitat exists to support amphibian populations into the future.

Prior to the 2006 mountain lakes field season, a long-term monitoring study design and protocol was developed for mountain lakes. The study design and protocol addressed the amphibian risk assessment that has been developed through previous studies and inventories of mountain lakes conducted within north-central Idaho (Schriever 2006).

The amphibian risk assessment is based on the amount of fishless habitat that exists within a watershed at the HUC5 level. At the individual HUC5 watershed level, it is assumed monitoring will be able to examine conditions that may dictate local response in the interactions of stocked fish and native amphibian populations to provide a more defined opportunity for prioritized management action (Murphy 2002). While there are many risk factors associated with amphibian declines, our assessment focused on considering impacts that may be associated with native and stocked fish in lakes on a HUC5 watershed basis. The amphibian risk assessment for these high mountain lake ecosystems has four categories: control (no risk), low, moderate, and elevated (Figure 1).

- *Control (no risk)* – watershed has never experienced fish introductions through stocking activities.
- *Low* – At least 50% of the lakes within a watershed are fishless AND a minimum 20% of the lake surface area within the watershed is fishless.
- *Moderate* – 50% of lakes within a watershed are fishless OR 20% of surface area is fishless.
- *Elevated* – Meets neither requirement, less than 50% of the lakes within a watershed are fishless AND less than 20% of the surface area within the watershed is considered fishless.

Two watersheds (HUC5) were selected randomly from each of the amphibian risk categories (region-wide from all HUC5 watersheds that contained lakes) for sampling. This resulted in eight HUC5 watersheds containing 72 lakes within the Nez Perce-Clearwater National Forest. In 2013, a third randomly selected control watershed (Big Harrington Creek in the Bitterroot National Forest was added to increase the sample size of fishless control lakes, bringing the study's total to nine watersheds that contain 74 lakes. Attempts will be made to sample all lakes within a selected HUC5 watershed within the same field season. The 20-year period for the high mountain lakes long-term monitoring project will allow for each of these lakes be sampled five different times. The repetition of sampling events will allow for comparisons to be made within (for trends) and between watersheds (for comparisons among amphibian risk classes). In addition, repetition of sampling events will address the normal patterns of recruitment fluctuations often common among amphibian populations. Sampling frequency and rotation order are adjusted to accommodate weather and fire conditions.

OBJECTIVES

1. Evaluate the long-term impacts of fish on amphibian populations within the high mountain lake ecosystems in the IDFG Clearwater Region.

2. Assess whether current fish management in high mountain lakes of North Central Idaho is sufficient to provide long-term persistence of amphibian populations.

STUDY AREA

The 74 lakes selected for this study are located in the Bitterroot National Forest and the Nez Perce-Clearwater National Forest, both located in north-central Idaho (Figure 40). In 2015, IDFG personnel surveyed 25 lakes within six HUC5 watersheds: Old Man Creek, Warm Springs Creek, Running Creek, Goat Creek, and Upper Meadow Creek in the Nez Perce-Clearwater National Forest, and Big Harrington Creek in the Bitterroot National Forest (Table 8).

Photographs, travel routes and bathymetric/surrounding area maps of lakes within the HUC5 watersheds are maintained in the Clearwater Region office within the mountain lakes database. Available files are located in the IDFG Clearwater Region shared drive at the address: S:\Fishery\MTN Lakes\Long Term Monitoring\Photos, Lake Maps, Routes.

METHODS

Field Sampling

Fish and amphibian data were collected according to the standard protocol used throughout the duration of this project. This protocol was updated and revised after the 2013 field season to improve the accuracy and comparability of results from year to year and is described in Hand et al. (2016b). One notable difference from this protocol is that we now perform two VES surveys within a 24-hour timeframe when possible to allow for estimating detection probabilities.

Laboratory Analysis

Fish scales were photographed under magnification (20-60x) and catalogued. In the future, they may be analyzed to determine age and growth rates, or be compared to stocking records to determine if natural recruitment is occurring.

Zooplankton were subsampled (n >200 for each unique combination of site, survey date, and depth) and identified under magnification to the taxon levels using the methodology described in Hand et al. (2016b).

Statistical Analysis

The methods for statistical analysis conducted in 2015 are explained in detail in Hand et al. (2016b). To supplement the 2013 description, we included Appendix B with a copy of the code for the best distribution and trend models (Zeileis et. al., 2008; Bronström 2013; Bates et.al. 2014; R Core Team 2014).

This year we were able to complete two visual surveys (within 24 h) on 20 lakes. We were also able to complete three different surveys on four different lakes. We fit a zero-inflated error distribution to this subset of surveys, which match the assumptions of such a distribution better than the whole dataset.

RESULTS

Among Clearwater Region lakes >1,500 m in elevation (*n* = 703), fish-containing lakes are on average larger and deeper than fishless lakes (Hand et al. 2016b). The lakes selected for this monitoring study (*n* = 74) closely mimic regional patterns. In 2015, mountain lakes field personnel surveyed 25 lakes from six HUC5 watersheds. Eight of the 25 surveyed lakes contained fish; the other 17 lakes were fishless. On the initial survey we detected Columbia Spotted Frogs in 17 lakes and Long-toed Salamanders in 11 lakes (Table 8).

Fish Surveys

Eight of the 25 surveyed lakes contained fish (Table 8). Five lakes had WCT and three had BKT. Due to equipment problems we were unable to sample one of the lakes with fish (West Wind) during 2015. Gill net CPUE ranged from 0.6 - 8.0 fish/h, with an average of 2.6 fish/h (Table 9). Average lengths and weights for fish caught by gill net in 2015 are outlined in Table 9. Length-frequency distributions for the most common fish in these seven lakes are shown in

Figure 44. All but two of these lakes showed a shift towards smaller fish compared to previous samples. In contrast, Running Lake and East Maude Lake appeared to have similar length-frequency distributions to the previous survey.

Columbia Spotted Frog Abundance and Distribution

Columbia Spotted Frogs were detected in 17 of 25 survey lakes (68%) sampled in 2015 (Table 8). In the first round of sampling, 63 of 74 lakes (85.1%) had CSF present. Of these, 23 (36.5%) lakes had fish present and 40 (63.5%) did not have fish present.

With the completion of the 2015 field season, we were able to finish the second round survey of the 74 lakes in the study. There was no change in CSF presence after the second round of surveys with 63 of 74 lakes containing CSF (85.1%). Twenty four lakes (32.4%) with CSF had fish present and 50 (67.5%) lakes had no fish. This year 18 lakes were sampled for the third time since the start of the study. Fifteen (83.3%) had CSF present, and of these eight (53.3%) had fish and seven (46.6%) had no fish.

Five of the lakes that we surveyed in 2015 showed a change in CSF presence (Bilk Mountain, Section 27, Big Harrington #6, and Section 26 Upper & Lower). All of these lakes showed a loss of CSF in comparison with previous surveys.

In 2015, no explanatory variables were significant in the CSF occurrence model. With the inclusion of the 2014 data, seasonal trends (Julian Day and (Julian day)^2) became significant (P <0.001). Because there were very few surveys in which CSF weren't present, we altered the binary response variable in the model so that it only treated lakes as having CSF present when there were at least three adult CSF recorded during the survey (CSF>2). This allowed us to present new variables that may be playing a larger role in CSF occurrence. When the binary response variable was altered to indicate counts of at least three adults, three additional explanatory variables became significant: Fines (P = 0.001), Depth (P = 0.018), Julian Day (P <0.001), and (Julian day)^2 (P <0.001). The results from this model, both significant and insignificant can be viewed in detail in Table 10. Fish presence did not affect CSF presence with either response variable.

Long-toed Salamander Abundance and Distribution

Long-toed Salamanders were initially detected in 11 of 25 surveyed lakes (44%) sampled in 2015 (Table 8). In the first round of sampling, 27 of 74 lakes (36.5%) had LTS present. Of these, three lakes (11%) had fish present and 24 (88.8%) did not have fish present.

With the completion of the 2015 field season we were able to finish the second round survey of the 74 lakes in the study. Of these, 27 (36.5%) had LTS present. As with CSF, this represents no change in occupancy compared to the first round of sampling. Five lakes with LTS had fish present and 22 lakes had no fish. This year 12 lakes were sampled for the third season. Five (41.7%) had LTS present, of which only one contained fish.

Mirroring the 2014 analysis, the best presence model for 2015 included three significant habitat variables: Fish (P <0.001), Julian Day (P <0.001), and (Julian day)^2 (P <0.001). Like 2014, the best model to find statistically significant variables pertaining to the number of amphibians that we saw during each survey included all of the variables except Elevation. Depth, Fish, Julian Day, (Julian day)^2, Snow, and Fines all were statistically significant (all with P <0.001).

Zero-Inflated Distribution and Detection Probabilities

Twenty lakes were surveyed multiple times within 24 hours in 2015. Columbia Spotted Frogs were detected in 41 out of 46 (89%) of these surveys. These factors made fitting a zero-inflated error distribution to this subset of the data inappropriate, and justifies an assumption that CSF detection probability approaches one.

We detected LTS in 11 of the 20 lakes (55%), and in 16 of 46 surveys (35%), therefore meeting the criteria outlined in Tyre et al. (2003) for fitting a zero-inflated error distribution. We used a zero-inflated Poisson distribution in this case, because that was found as the best distribution for the LTS composite counts in the whole dataset. Using the distribution coefficient of -1.74 we derived a detection probability of 0.65 for LTS in this subset of lakes. This is an increase from the detection probability of 0.55 calculated in 2014.

Long-term Trends in Presence and Abundance

As in 2014, the occurrence of CSF remained fairly constant across time in all lakes in the study. A logistic regression confirmed that there was still no significant long-term trend in CSF presence (P = 0.206). Long-toed Salamander occurrence has been more variable, though logistic regression did not yield a significant trend (P = 0.813).

Contrary to the presence models, “Year” was a highly significant variable in both the CSF (P <0.001) and the LTS (P <0.001) abundance models. They also indicate a positive trend in counts for both species over time.

Chi-Square Analysis of Historical Through Second Round Survey Data

With the conclusion of the 2015 field season, we were able to finish our second round of surveys for all 74 lakes in the study. To determine whether there were statistically significant changes in CSF and LTS presence and absence, we ran the data through a Chi-Square Analysis.

The results of this analysis were broken down into three different tables: Historical to 1st round (Table 11), 1st round to 2nd round (Table 12), and historical to 2nd round (Table 13). It should also be noted that the overall number of lakes in this analysis increases from 55 total lakes in the historical survey to 74 lakes in the first and second round of surveys. We only have historic data on 55 out of 74 (74%) of the lakes in the study.

When looking at the change in presence and absence between Historical (pre-2006) and 1st round survey data for CSF, there were no statistically significant relationships (Table 11). When looking at LTS presence and absence between Historic and 1st round survey data, there were three statistically-significant probabilities found: the all lakes category (P = 0.015), the Control category (P <0.001), and the Low Risk category (P <0.001). The Low Risk Category showed the most highly significant change, as nine lakes that historically contained LTS did not have LTS in the 1st round of sampling.

The 1st round to 2nd round Chi Square analysis compared all 74 lakes in the study (Table 12). There was one statistically significant change for CSF. In the Control group, two fewer lakes had CSF in the 2nd round (P = 0.033). Long-toed Salamanders had three, statistically-significant changes: in the Low Risk category, 10 more lakes had LTS than expected (P <0.001), in the All Lakes category 10 more lakes had LTS than expected (P = 0.016), and in the fish present category 4 more lakes had LTS than expected (P = 0.015).

Seasonal Variation in Amphibian Presence

During the 2015 field season, we were able to sample the Wind Lakes in the Warm Springs Creek drainage at two separate times of the year. We did this in order to begin to understand seasonal variation in amphibian presence. The first survey was done from July 22 - 26, 2015 and the second survey was done from September 20 - 21, 2015. During the July survey, CSF were observed in seven of the eight lakes (87.5%), and LTS were observed in four of the eight lakes (50%). During the September survey, CSF were observed in two of the eight lakes (25%), and LTS were observed in one of the eight lakes (12.5%).

DISCUSSION

Amphibian Surveys

During the 2015 field season we visited several lakes that showed a marked change in habitat quality. Bilk Mountain has turned into a meadow with little to no standing water. Big Harrington #6 and Section 26 Upper & Lower were completely dry. Section 27 was below 50% of its volume compared to photographs taken in previous surveys. These changes in habitat quality and quantity were likely a primary reason for losses of amphibian presence at the sites. A much lower than average snowpack during the 2014-2015 winter likely contributed to the lakes drying up and Section 27 losing most of its volume (Figure 41). In fact, this winter had one of the lowest snow-water equivalents (quantity of water contained in the snowpack) of any year since 1984 (Figure 41; NRCS 2018). It will be interesting to see when or if amphibians return to these lakes during the remainder of this project.

Habitat Variables

Habitat relationships for both LTS and CSF were generally consistent with previous studies (Pilliod et al. 1996; Murphy 2002). Columbia Spotted Frog occurrence seemed to be driven by Fines and Depth, though this binary response should be interpreted with caution as Lake Depth is positively correlated with Lake Perimeter. The count models account for this by offsetting the Lake Perimeter, but this was not part of the presence models. Whether this relationship is biased or not, fish presence does not seem to have a significant effect on CSF presence within the study.

However, fish presence does show a significant effect on LTS presence and counts. This is likely attributable to the two-year larval stage of LTS which increases their susceptibility to predation during this life stage. This relationship was clearest in the presence model, hinting that on a landscape scale, reducing the number of stocked lakes may provide more suitable salamander habitat. Especially compared to last year's analysis, the best count model for LTS ended up highly parameterized, including three significant habitat variables (Depth, Fish Presence, and Fines). The inclusion of Depth and Fines may be the product of either or both of two processes. Depth and Fines correlate with Fish presence, and appear to determine LTS counts by co-linearity. They may also affect detectability of LTS in their habitat, driving the count rather than true abundance. Using a Zero-Inflated Model would correct for this latter process, but we do not have enough data to converge such models. With the detection probability being $p = 0.55$ in 2014, we continued to account for detectability in 2015 by sampling 20 separate lakes at least twice. This increased our detectability to $p = 0.65$. The increase in LTS detectability between 2014 and 2015 further supports our decision to incorporate multiple VES's at a given lake during a 24-hour period whenever possible. The increase from $p = 0.55$ to 0.65 is substantial enough to indicate that our efforts to improve detectability are working. This also suggests that conducting single VES surveys is less effective for determining presence/absence of LTS in high mountain lakes.

Temporal Variables

As was seen in previous years, Julian Day and $(\text{Julian Day})^2$ proved to be highly significant variables in every count and presence model. We were able to see how much Julian Day and $(\text{Julian Day})^2$ affected amphibian occurrence and count in 2015 when we sampled the Wind Lakes (Warm Springs Creek HUC5) at two separate times of the year (July and September) to determine the effects of seasonality on amphibian presence. These surveys showed a marked decrease in presence of both amphibian species during the September survey, with CSF presence declining from 87.5% to 25%, and LTS declining from 50% to 12.5%. While factors such as poor weather or visibility could influence amphibian presence, these issues were not the case during our surveys in 2015, and have occurred rarely during the course of this study. Therefore, the most likely drivers for the decline in presence and abundance are time of year and the resulting drop in water temperature later in the season. For CSF, observations during VES surveys drops from >80% to <60% beginning around September 17th (Julian date = 260) (Figure 42). Long-toed salamander observations stop occurring around September 27th (Julian date = 270; Figure 42). This coincides with the decline in water temperature that occurs in the fall. For CSF we see a sharp decrease in observations (and abundance) at 10ºC (Figure 43). For LTS, this decrease occurs at around 8ºC (Figure 43).

This strong seasonality should be taken into account when developing sampling plans for the remainder of this study. We recommend ending field sampling when water temperatures decrease below 8ºC. Additionally, we recommend continuing to sample one set of lakes at two different times each year to provide more data for this analysis.

Zero Inflated Models and Detection Rates

This year we continued to perform multiple VES's on a subset of lakes with the intention of addressing the question brought up in 2014: Within our resource constraints within a given year, should we prioritize our time by sampling more lakes each year, or sample fewer lakes more often? The key to answering this question was the difference between the variation among surveys conducted within a year and between years at the same site. A lower detection probability will generally produce more variation within a year (or with a closed population), and require more replicate surveys to accurately estimate changes between years. If CSF were the exclusive species of interest, there would be no reason to conduct multiple surveys a year at a given site. Their counts require no adjustment for detection to assume a close relationship between occurrence/count and presence/abundance.

For LTS, in 2014 our estimate was very close to the $p = 0.5$ cutoff recommended in the literature (Tyre et.al. 2003). In 2015, the detection probability estimate increased to $p = 0.65$. This increase in detection probability indicates that it would be beneficial to spend more time doing additional VES's on lakes rather than getting just one VES done during each visit. Literature recommends at least three closed-population replicates to estimate detection probabilities with a zero-inflated error distribution (Tyre et.al. 2003). We recommend allocating resources from gillnetting to continue focusing on conducting multiple VES's done during each visit to a lake. More amphibian surveys with a closed population would yield a more precise and representative estimate of detection probability for LTS. This estimate would help prioritize resources and further improve distribution and trend models.

Long Term Trends

As seen with the power analysis conducted in 2013, we detected no significant trends in occupancy of either CSF or LTS with the addition of the 2014 and 2015 data. The count models indicate highly significant positive trends, but these results should be interpreted with caution. Several factors can influence amphibian counts and detectability during a given season. Amphibian populations are known to fluctuate widely from year to year (Gibbs, 1993), and an estimate of linear population trends may not be generalizable to future years yet. Detection and classification also probably vary by personnel. With field personnel changing every season, there is a strong chance that detection and identification can vary from year to year. Between the 2014 and 2015 seasons there were six different people who assisted with the sampling. Bias could also stem from using different criteria to differentiate life stages, or from growth rates (therefore population structure) varying between years. The trends for CSF became less significant and had lower coefficients when we used models with a composite score of adults and sub-adults. The significance of Snow in the CSF count distribution model is probably also a product of the above processes, since the Snow value is the same across a given year. More explicit identification training and a larger dataset will mitigate these biases in the future and give a clearer picture of long-term population trends.

Fish Surveys

For five of the seven fish containing lakes sampled in 2015, length-frequency distributions showed that fish were smaller than what was documented in 2012 (
Figure 44). This could be the result of numerous effects such as higher natural reproduction resulting in smaller average fish sizes, stocking, harvest of larger fish by anglers, or natural mortality from lack of food resources. The other two lakes (Running and East Maude) showed little to no change. Of these lakes, on East and West Maude lakes are stocked, with the most recent stocking occurring in 2013. This could influence the number of small fish sampled, however, both of these lakes saw substantially lower CPUE in 2015 versus 2012 (Table 9). This decline was also seen in most of the other lakes sampled in 2015, which were not stocked. This suggests that the smaller fish are more likely the result of higher mortality (angler and/or natural). The poor water conditions mentioned previously may have contributed to increased natural mortality.

Gillnetting has occurred at least twice in all lakes where fish have been identified to be present. Fish presence appears relatively constant across the lakes over time (Table 14). Lake Creek South contained WCT and RBT during the historical survey, but RBT were the only species observed in the following first round survey. The loss of all fish in the lake (presumably) was observed during the second round survey in 2014. While our surveys suggests that fish species composition and/or presence has changed over time in several lakes, this is likely due to either identification error (species changes), or low sampling effort (fish presence; Table 14).

MANAGEMENT RECOMMENDATIONS

1. Continue monitoring high mountain lakes within HUC5 watersheds in the Clearwater Region as part of the long-term amphibian risk assessment.

2. Continue conducting 2-3 Visual Encounter Surveys during one visit to each lake surveyed in a season to improve LTS detection probabilities.

3. Consider reducing gillnetting efforts and re-allocate that time and energy to conducting more amphibian surveys, as fish presence is relatively consistent.

4. Continue sampling a set of lakes within the same watershed at two or more separate times of the year to better understand the effects of seasonality.

5. Include seasonal variation in any future analysis used to detect trends or habitat associations.

ACKNOWLEDGEMENTS

Funding for 2015 high mountain lakes monitoring project was a shared effort between the IDFG Clearwater Region and USFS Clearwater National Forest and Nez Perce National Forest. Personnel from IDFG cooperated on monitoring of lakes in the Clearwater National Forest, Nez Perce National Forest, and Selway-Bitterroot Wilderness. Statistical analysis was assisted by Landon Moore, 2014 High Mountain Lakes Technician. Field personnel that aided in 2015 mountain lakes monitoring include: Kyle Jemmett, William Gentry, and Irene Shaver IDFG Clearwater Region.

Table 8. Clearwater Region high mountain lakes surveyed in 2015 showing fish gill net CPUE (number of fish/net hour), Columbia Spotted Frog (CSF) presence, and Long-toed salamander (LTS) presence on initial survey.

Lake Name	Risk	HUC5	HUC4	Survey Date	Gill Net CPUE	CSF	LTS
Lottie	Elevated	Old Man Creek	Lochsa	7/9/2015	3.5	Yes	No
Lottie (Upper)	Elevated	Old Man Creek	Lochsa	7/10/2015	0.6	Yes	No
Maude North	Elevated	Old Man Creek	Lochsa	7/10/2015	--	Yes	Yes
Maude West	Elevated	Old Man Creek	Lochsa	7/11/2015	0.5	Yes	Yes
Maude East	Elevated	Old Man Creek	Lochsa	7/11/2015	1.2	Yes	No
Middle Wind	Moderate	Warm Springs Crk	Lochsa	7/22/2015	2.3	Yes	No
East Wind	Moderate	Warm Springs Crk	Lochsa	7/23/2015	2.2	Yes	No
South Wind	Moderate	Warm Springs Crk	Lochsa	7/24/2015	--	Yes	Yes
North Wind (Lower)	Moderate	Warm Springs Crk	Lochsa	7/25/2015	--	No	No
North Wind (Upper)	Moderate	Warm Springs Crk	Lochsa	7/25/2015	--	Yes	Yes
Wind Pond	Moderate	Warm Springs Crk	Lochsa	7/23/2015	--	Yes	Yes
North West Wind	Moderate	Warm Springs Crk	Lochsa	7/26/2015	--	Yes	No
West Wind	Moderate	Warm Springs Crk	Lochsa	7/24/2015	No Data	Yes	Yes
Running	Moderate	Running Creek	Upper Selway	8/5/2015	8.0	Yes	No
Section 26 (Lower)	Moderate	Running Creek	Upper Selway	8/12/2015	--	No	No
Section 26 (Upper)	Moderate	Running Creek	Upper Selway	8/12/2015	--	No	No
Bilk Mountain	Control	Goat Creek	Upper Selway	8/10/2015	--	No	No
Goat GC	Control	Goat Creek	Upper Selway	8/8/2015	--	Yes	Yes
Mud	Control	Goat Creek	Upper Selway	8/7/2015	--	Yes	Yes
Bilk	Control	Upper Meadow	Upper Selway	8/9/2015	--	Yes	Yes
Section 27	Control	Upper Meadow	Upper Selway	8/6/2015	--	No	Yes
Elk	Control	Upper Meadow	Upper Selway	8/11/2015	--	Yes	Yes
Big Harrington 1	Control	Big Harrington	Middle Salmon	8/22/2015	--	No	No
Big Harrington 6	Control	Big Harrington	Middle Salmon	8/21/2015	--	No	No
Middle Wind	Moderate	Warm Springs Crk	Lochsa	9/21/2015	--	No	No
East Wind	Moderate	Warm Springs Crk	Lochsa	9/21/2015	--	Yes	No
South Wind	Moderate	Warm Springs Crk	Lochsa	9/21/2015	--	No	Yes
North Wind (Lower)	Moderate	Warm Springs Crk	Lochsa	9/20/2015	--	No	No
North Wind (Upper)	Moderate	Warm Springs Crk	Lochsa	9/20/2015	--	No	No
Wind Pond	Moderate	Warm Springs Crk	Lochsa	9/21/2015	--	No	No
North West Wind	Moderate	Warm Springs Crk	Lochsa	9/21/2015	--	No	No
West Wind	Moderate	Warm Springs Crk	Lochsa	9/20/2015	--	Yes	No

Table 9. Summary of gill net catch-per-unit-effort (CPUE), and average total length (mm) and weight (g) of Brook Trout (BKT) and Westslope Cutthroat Trout (WCT) captured during high mountain lake surveys in the Clearwater Region, Idaho, in 2015.

		Gillnet CPUE			
Lake	Species	2015	2012	Average	Average
Lottie	BKT	3.5	3.4	161	42
Lottie (Upper)	BKT	0.6	2.1	138	53
Maude West	WCT	0.5	1.1	228	160
Maude East	WCT	1.2	2.1	204	132
Middle Wind	WCT	2.3	4.2	85	124
East Wind	WCT	2.2	0.9	132	81
Running	BKT	8.0	5.9	181	58

Table 10. Variables and respective *P*-values for the Columbia Spotted Frog (CSF)>2 Occurrence Model.

Variable	P-Value
Fines	0.00141
Depth	0.01811
J.Day	p<0.001
J.Day^2	p<0.001
Fish presence	0.66157
Elevation	0.17859
Snow	0.12361

Table 11. Chi-Square analysis of CSF/LTS presence and absence between historical surveys (pre - 2006) and first round surveys (2006 - 2013) conducted in 55 Clearwater Region high mountain lakes.

Columbia Spotted Frogs

Lake risk level	Present (actual)	Not found (actual)	Present (expected)	Not found (expected)	χ^2	Probability
All Lakes	48	7	51	4	2.46	0.1190
Control	4	0	4	0	n/a	n/a
Low	16	2	18	0	n/a	n/a
Moderate	9	2	10	1	1.1	0.2940
Elevated	19	3	19	3	1.57E-18	1
Fish Present	24	5	26	3	1.49E+00	0.2227
No Fish	24	2	25	1	1.04E+00	0.3078

Long-toed Salamanders

Lake risk level	Present (actual)	Not found (actual)	Present (expected)	Not found (expected)	χ^2	Probability
All Lakes	17	38	28	27	5.89	0.0150
Control	4	0	1	3	12	0.0005
Low	2	16	11	7	18.94	1.35E-05
Moderate	4	7	7	4	3.54	0.0600
Elevated	8	14	8	14	0	1
Fish Present	6	23	6	23	0.00E+00	1
No Fish	24	2	21	5	2.23E+00	0.1355

Table 12. Chi-Square analysis of Columbia Spotted Frogs and Long Toed Salamander presence between first round surveys (2006 - 2013) and second round surveys (2011 - 2015) conducted in 74 Clearwater Region high mountain lakes.

Columbia Spotted Frogs

Lake risk level	Present (actual)	Not found (actual)	Present (expected)	Not found (expected)	χ^2	Probability
All Lakes	63	11	63	11	0	1
Control	5	3	7	1	4.57	0.0325
Low	26	2	26	2	0	1
Moderate	11	3	9	5	1.24	0.2646
Elevated	21	3	21	3	0	1
Fish Present	26	2	24	4	1.17E+00	0.2801
No Fish	37	9	39	7	6.74E-01	0.4117

Long-toed Salamanders

Lake risk level	Present (actual)	Not found (actual)	Present (expected)	Not found (expected)	χ^2	Probability
All Lakes	37	37	27	47	5.83	0.0157
Control	4	4	6	2	2.67	0.1025
Low	18	10	8	20	17.50	2.873E-05
Moderate	5	9	5	9	0.00	1
Elevated	10	14	8	16	0.75	0.3865
Fish Present	7	21	3	25	5.97E+00	0.0145
No Fish	30	16	24	22	3.14E+00	0.0766

Table 13. Chi-Square analysis of Columbia Spotted Frogs and Long Toed Salamander presence between historical surveys (pre-2006) and second round surveys (2011 - 2015) conducted in 55 Clearwater Region high mountain lakes.

Columbia Spotted Frogs

Lake risk level	Present (actual)	Not found (actual)	Present (expected)	Not found (expected)	χ^2	Probability
All Lakes	50	5	51	4	0.27	0.6036
Control	4	0	4	0	n/a	n/a
Low	17	1	18	0	n/a	n/a
Moderate	10	1	10	1	0	1
Elevated	19	3	19	3	0	1
Fish Present	26	3	26	3	0.00E+00	1
No Fish	24	2	25	1	1.04E+00	0.3078

Long-toed Salamanders

Lake risk level	Present (actual)	Not found (actual)	Present (expected)	Not found (expected)	χ^2	Probability
All Lakes	28	27	28	27	0	1
Control	3	1	1	3	5.33	0.0209
Low	11	7	11	7	0	1
Moderate	5	6	7	4	1.57	0.2100
Elevated	9	13	8	14	0.20	0.6576
Fish Present	9	20	6	23	1.89E+00	0.1691
No Fish	19	7	21	5	9.90E-01	0.3196

Table 14. Fish and amphibian presence in Clearwater Region high mountain lakes determined from historic surveys (pre-2006) and subsequent surveys used to assess amphibian persistence.

			Historical		First round		Second round		Third round	
Lake name	Huc 5	Risk category	Fish	Amphibians	Fish	Amphibians	Fish	Amphibians	Fish	Amphibians
Bilk Mountain	Goat Creek	Control	NONE	CSF	NONE	CSF/LTS	NONE	CSF	NONE	NONE
Goat	Goat Creek	Control	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS	--	--
Mud	Goat Creek	Control	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS	--	--
Bilk	Upper Meadow	Control	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS	--	--
Elk	Upper Meadow	Control	--	--	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
Section 27	Upper Meadow	Control	--	--	NONE	CSF/LTS	NONE	LTS	--	--
Big Harrington #1	Big Harrington	Control	--	--	NONE	NONE	NONE	NONE	--	--
Big Harrington #6	Big Harrington	Control	--	--	NONE	CSF	NONE	NONE	--	--
Fox Peak Lower	NF Moose Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS
Fox Peak Upper	NF Moose Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS
Isaac Creek	NF Moose Creek	Low	--	--	NONE	CSF	NONE	CSF/LTS	NONE	CSF
Isaac	NF Moose Creek	Low	WCT/RBT	CSF	WCT/RBT	CSF	WCT	CSF	WCT	CSF
Section 28	NF Moose Creek	Low	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS	--	--
West Moose #1	NF Moose Creek	Low	--	--	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
West Moose #2	NF Moose Creek	Low	--	--	NONE	CSF/LTS	NONE	CSF/LTS	--	--
West Moose #3	NF Moose Creek	Low	--	--	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
West Moose #4	NF Moose Creek	Low	--	--	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
West Moose #5	NF Moose Creek	Low	--	--	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS
West Moose #6	NF Moose Creek	Low	--	--	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
West Moose #7	NF Moose Creek	Low	--	--	NONE	CSF	NONE	CSF	NONE	CSF/LTS
West Moose #8	NF Moose Creek	Low	--	--	NONE	CSF	NONE	LTS	NONE	CSF
West Moose #9	NF Moose Creek	Low	--	--	NONE	CSF	NONE	CSF	NONE	CSF
Dan	Storm Creek	Low	RBT	CSF	RBT	CSF	RBT	CSF	--	--
Dodge	Storm Creek	Low	RBT	CSF	RBT	CSF	RBT	CSF	--	--
Lookout	Storm Creek	Low	RBT	CSF	RBT	CSF	RBT	CSF	--	--
Maud	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF	--	--
Middle Storm	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF
North Sec. 25	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS
North Storm	Storm Creek	Low	NONE	CSF	NONE	CSF	NONE	CSF/LTS	NONE	NONE
N.E. Ranger	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS
Old Stormy	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF	--	--
Ranger	Storm Creek	Low	RBT	CSF	RBT	NONE	RBT	CSF/LTS	RBT	NONE
Section 27	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS
Siah	Storm Creek	Low	WCT/RBT	CSF	WCT/RBT	CSF	WCT/RBT	CSF/LTS	WCT	CSF/LTS
South Sec. 25	Storm Creek	Low	NONE	CSF/LTS	NONE	CSF	NONE	CSF	NONE	CSF/LTS
Storm	Storm Creek	Low	NONE	CSF/LTS	NONE	NONE	NONE	LTS	NONE	NONE

CSF=Columbia Spotted Frog, LTS=Long Toed Salamander, TF=Rocky Mountain Tailed Frog, IGS=Idaho Giant Salamander
WCT=Westslope Cutthroat Trout, RT=Rainbow Trout, BT=Brook Trout

Table 14 (continued)

Lake name	Huc 5	Risk category	Historical		First round		Second round		Third round	
			Fish	Amphibians	Fish	Amphibians	Fish	Amphibians	Fish	Amphibians
Eagle Creek	Running Creek	Moderate	--	--	NONE	NONE	NONE	NONE	--	--
Running	Running Creek	Moderate	BKT	CSF	BKT	NONE	BKT	CSF	BKT	CSF
Section 26 Lower	Running Creek	Moderate	--	--	NONE	NONE	NONE	CSF	NONE	NONE
Section 26 Upper	Running Creek	Moderate	--	--	NONE	LTS	NONE	NONE	NONE	NONE
Dodge	Warm Springs Crk.	Moderate	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	--	--
East Wind	Warm Springs Crk.	Moderate	WCT	CSF/LTS	WCT	CSF	NONE	CSF	WCT	CSF
Hungry	Warm Springs Crk.	Moderate	WCT/RBT	CSF	WCT	CSF	WCT	CSF	--	--
Low. N. Wind	Warm Springs Crk.	Moderate	NONE	CSF/LTS	NONE	NONE	NONE	NONE	NONE	NONE
Middle Wind	Warm Springs Crk.	Moderate	WCT	CSF	WCT	CSF	WCT	CSF	WCT	CSF
N.W. Wind	Warm Springs Crk.	Moderate	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF	NONE	CSF
South Wind	Warm Springs Crk.	Moderate	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
Up. N. Wind	Warm Springs Crk.	Moderate	NONE	LTS	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
West Wind	Warm Springs Crk.	Moderate	WCT	CSF	WCT	CSF	WCT	CSF/LTS	WCT	CSF/LTS
Wind Pond	Warm Springs Crk.	Moderate	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS
Bleak Creek	Bargamin Creek	Elevated	NONE	CSF/LTS	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS
Boston Mtn.	Bargamin Creek	Elevated	WCT	CSF/LTS	WCT	CSF	WCT	CSF	WCT	CSF
Goat Lake	Bargamin Creek	Elevated	WCT	LTS	NONE	LTS	NONE	LTS	--	--
Lake Creek E.	Bargamin Creek	Elevated	WCT/RBT/X	CSF	WCT/RBT/X	CSF/LTS	WCT	CSF	--	--
Lake Creek. S.	Bargamin Creek	Elevated	WCT/RBT	CSF	RBT	CSF/TF	NONE	CSF	--	--
Lake Creek W.	Bargamin Creek	Elevated	RBT	CSF	RBT	CSF	WCT	CSF	--	--
MacArther	Bargamin Creek	Elevated	WCT/RBT	CSF/LTS	WCT/RBT	CSF	WCT/RBT	CSF/LTS	WCT	CSF
Stillman	Bargamin Creek	Elevated	WCT	CSF	WCT	CSF/LTS	WCT	CSF/LTS	WCT	CSF
Three Prong	Bargamin Creek	Elevated	--	--	NONE	CSF/IGS	NONE	CSF/IGS	--	--
Chimney	Old Man Creek	Elevated	BKT	NONE	BKT	CSF	BKT	CSF	--	--
Dishpan	Old Man Creek	Elevated	BKT	CSF	BKT	CSF	BKT	CSF	--	--
Elizabeth	Old Man Creek	Elevated	BKT/WCT	CSF	BKT/WCT	NONE	BKT/WCT	NONE	--	--
Flea	Old Man Creek	Elevated	NONE	CSF	NONE	CSF/LTS	NONE	CSF/LTS	--	--
Florence	Old Man Creek	Elevated	WCT	CSF/LTS	WCT	CSF/LTS	WCT	CSF	--	--
Hjort	Old Man Creek	Elevated	BKT	CSF	BKT	CSF	BKT/WCT	CSF	--	--
Kettle	Old Man Creek	Elevated	RBT	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS	--	--
Lloyd	Old Man Creek	Elevated	BKT	NONE	BKT	NONE	BKT	NONE	--	--
Lottie	Old Man Creek	Elevated	--	--	BKT	CSF	BKT	CSF	BKT	CSF
Lottie Upper	Old Man Creek	Elevated	BKT	CSF	BKT	CSF	BKT	CSF	BKT	CSF
Maude East	Old Man Creek	Elevated	RBT	CSF	RBT	CSF	WCT/HY	CSF/LTS	WCT	CSF
Maude North	Old Man Creek	Elevated	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF	NONE	CSF
Maude West	Old Man Creek	Elevated	RBT	CSF	RBT	CSF	WCT/HY	CSF/LTS	WCT	CSF
Old Man	Old Man Creek	Elevated	BKT	CSF	BKT	CSF	BKT	CSF	--	--
Wood	Old Man Creek	Elevated	NONE	CSF/LTS	NONE	CSF/LTS	NONE	CSF/LTS	--	--

CSF=Columbia Spotted Frog, LTS=Long Toed Salamander, TF=Rocky Mountain Tailed Frog, IGS=Idaho Giant Salamander, WCT=Westslope Cutthroat Trout, RT=Rainbow Trout, BT=Brook Trout

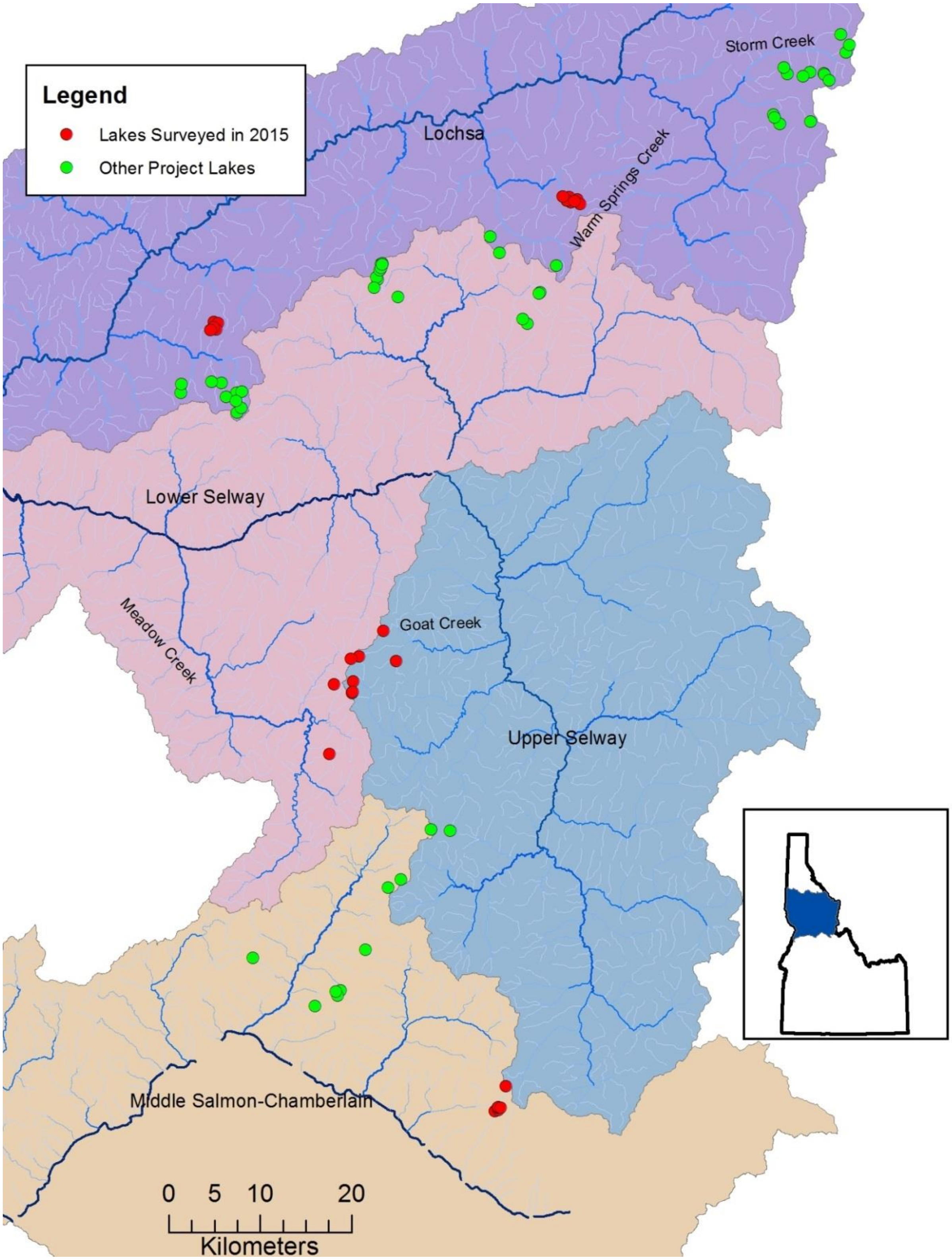


Figure 40. The locations of high mountain lakes that are being evaluated in the long-term monitoring project in the Clearwater Region of Idaho.

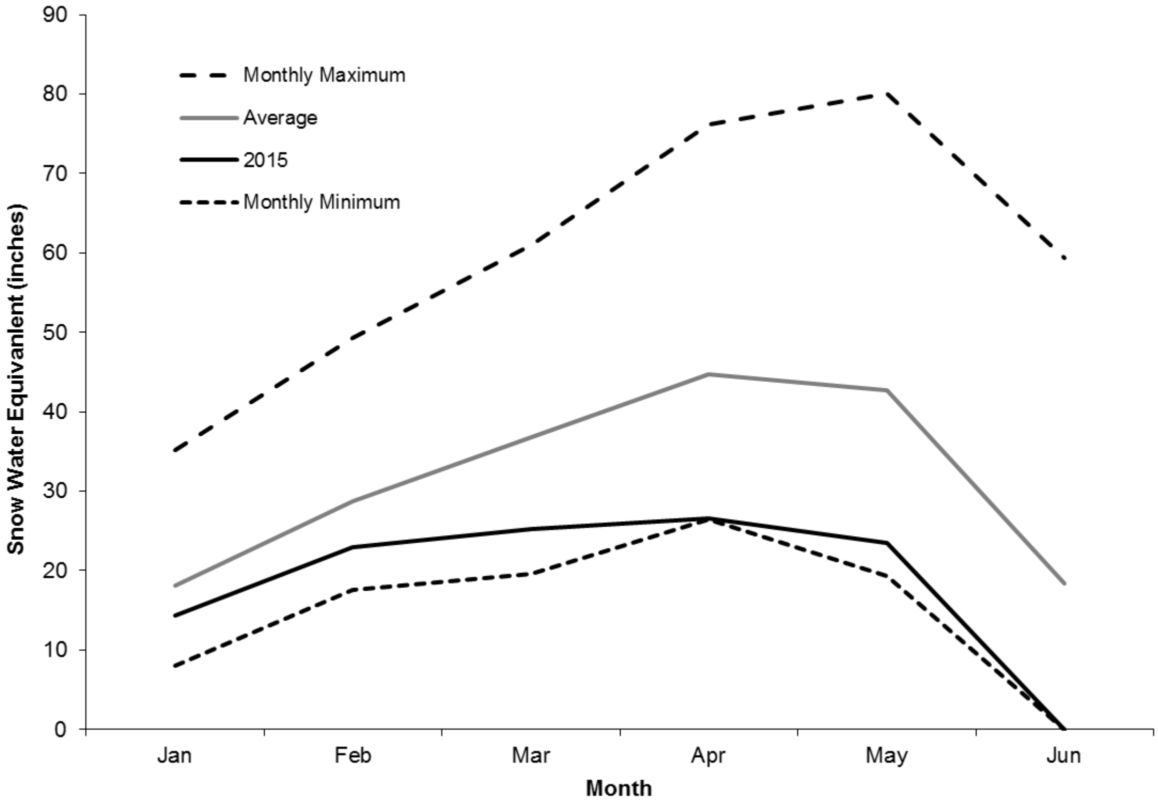


Figure 41. Monthly snow water equivalents for 2015, compared to the average, minimum, and maximum values from historic data (1984 - 2015) for the Clearwater River drainage, Idaho.

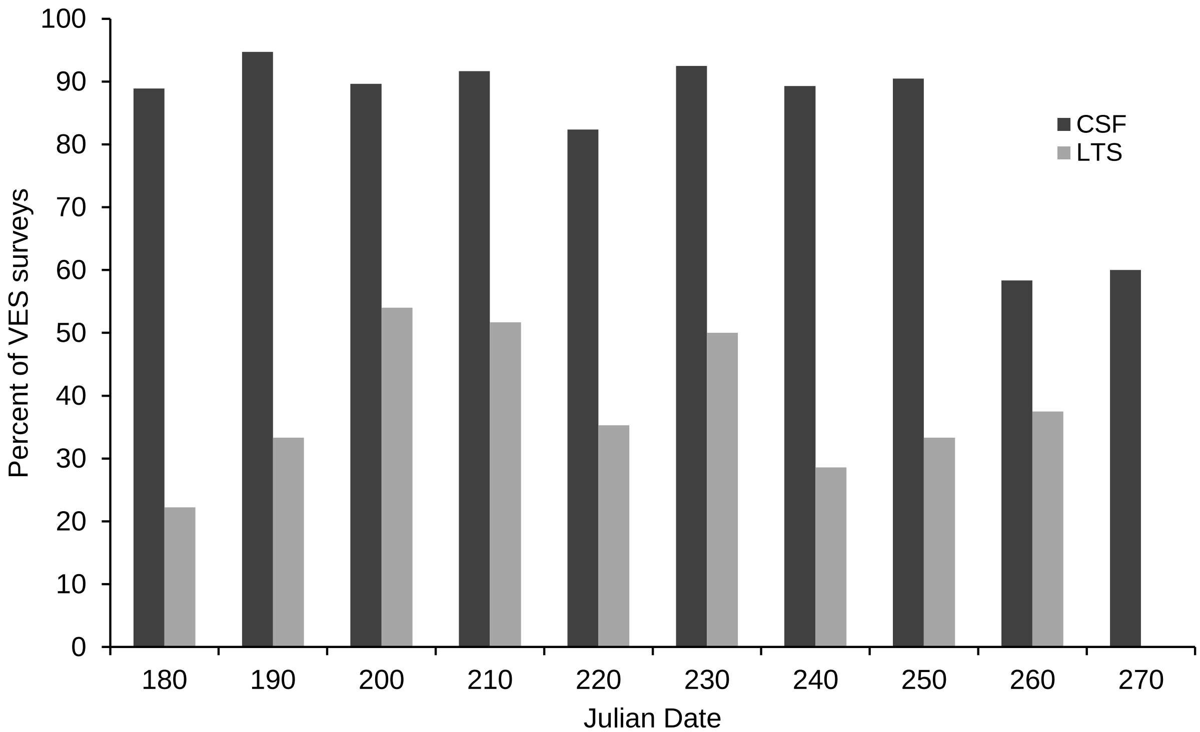


Figure 42. Percentage of visual encounter surveys (VES) with Columbia Spotted Frogs (CSF) and Long-toed Salamanders (LTS) present, based on Julian Date, for high mountain lakes in the Clearwater Region, Idaho.

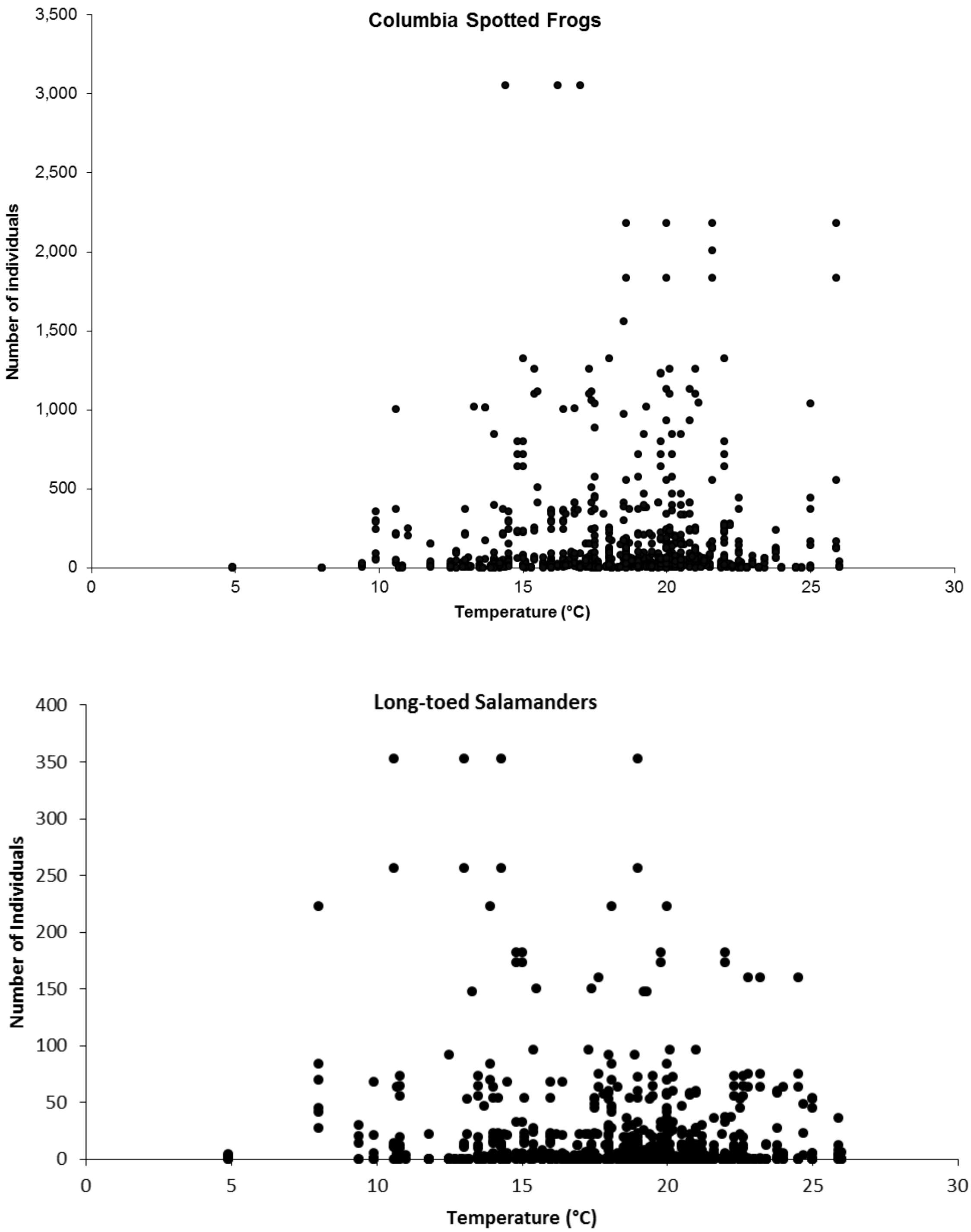
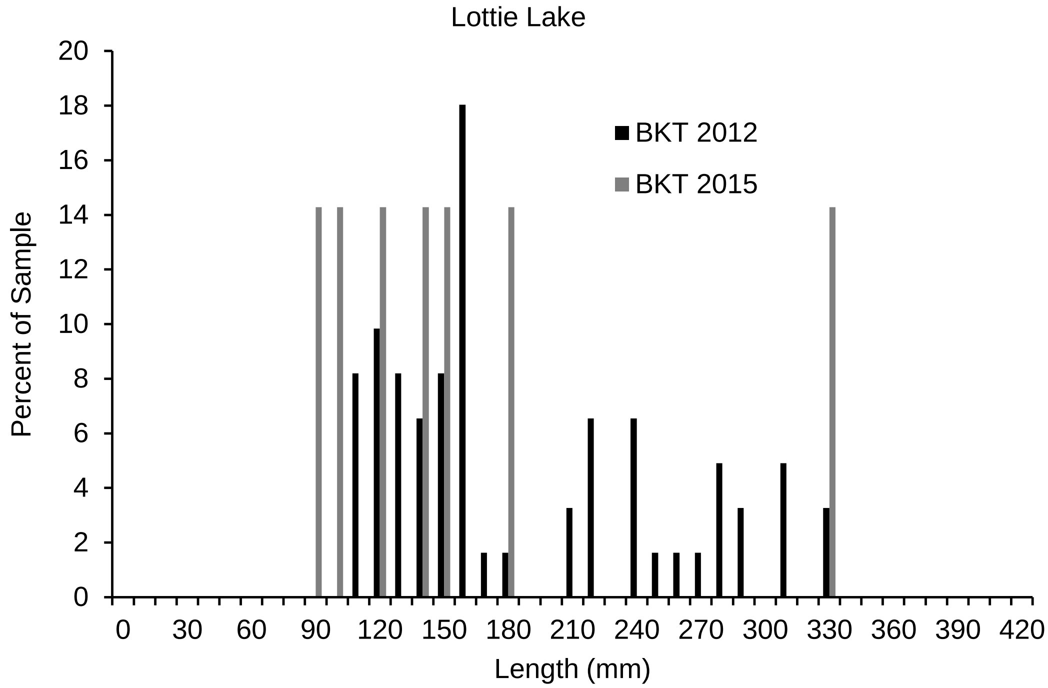


Figure 43. Abundance of Columbia Spotted Frogs and Long-toed Salamanders observed during visual encounter surveys of high mountain lakes in the Clearwater Region, Idaho, based on water temperature.



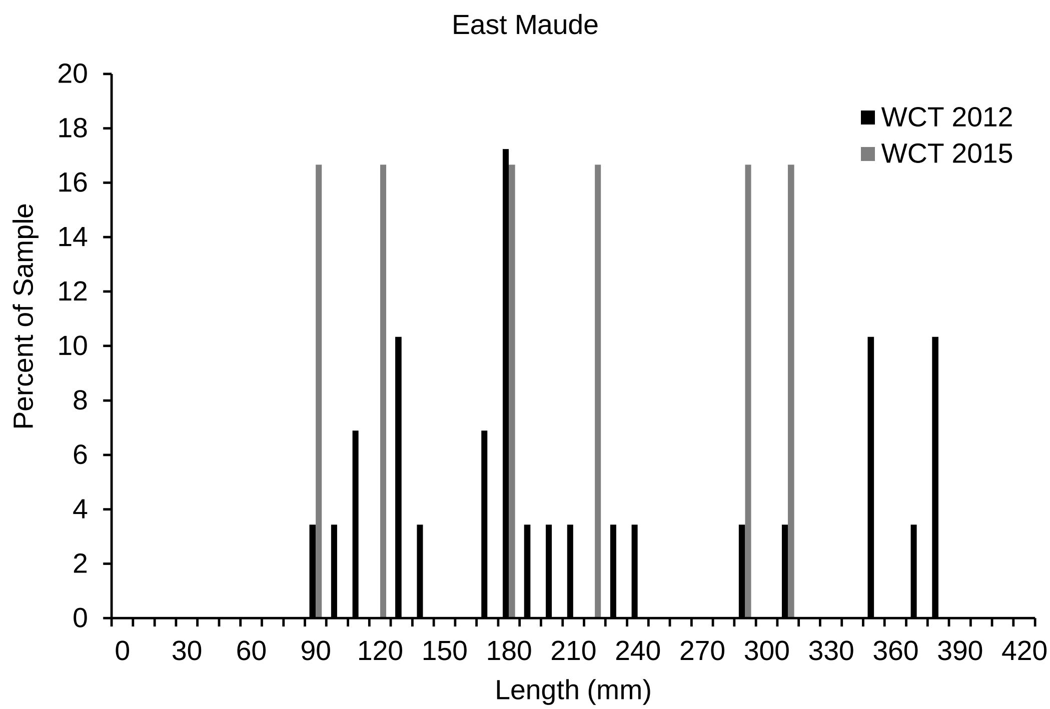
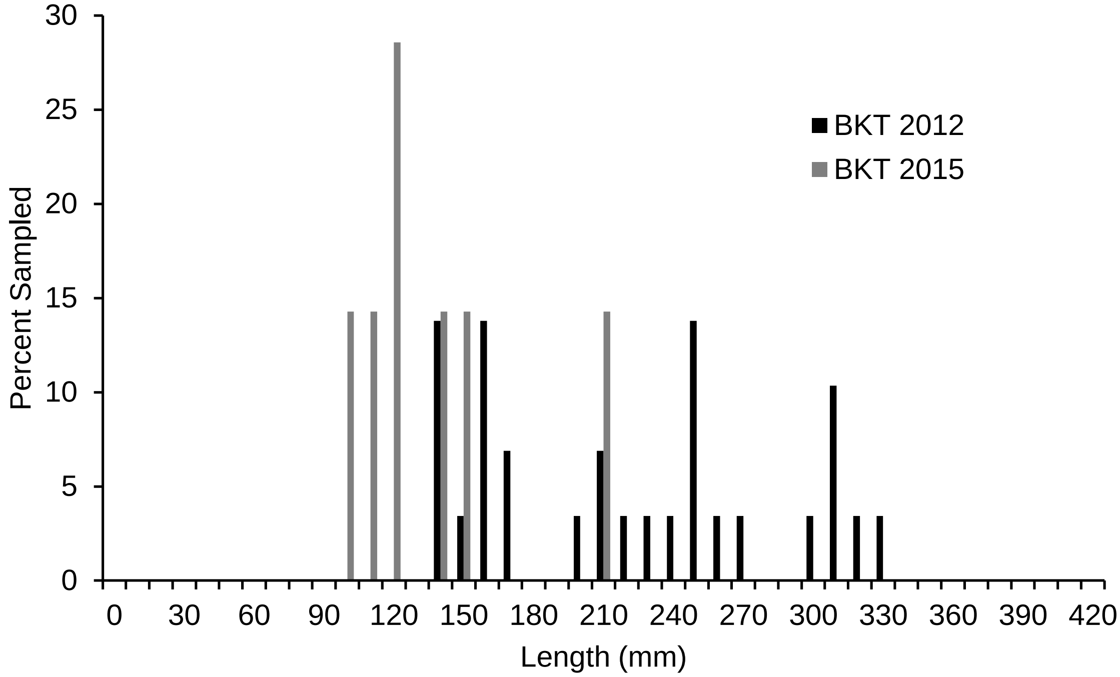


Figure 44. Length-frequency distributions of Westslope Cutthroat Trout (WCT) and Brook Trout (BKT) sampled by gill net in 2015 from high mountain lakes in the Clearwater Region, Idaho, compared to previous surveys.

Figure 44 (continued)

Upper Lottie Lake



West Maude

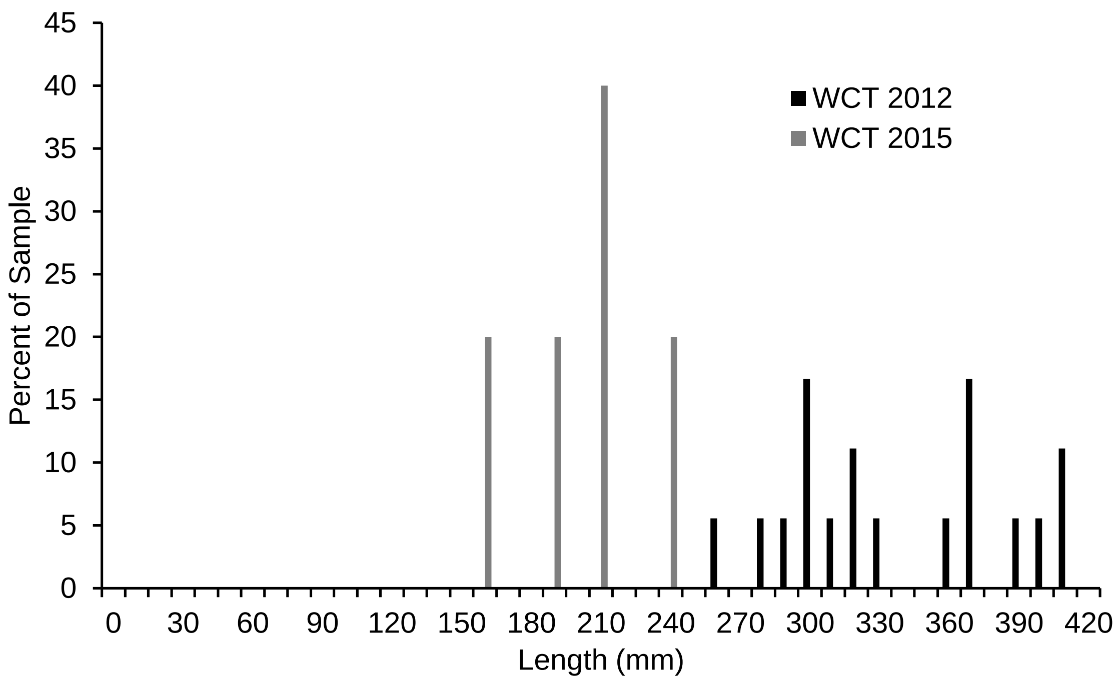
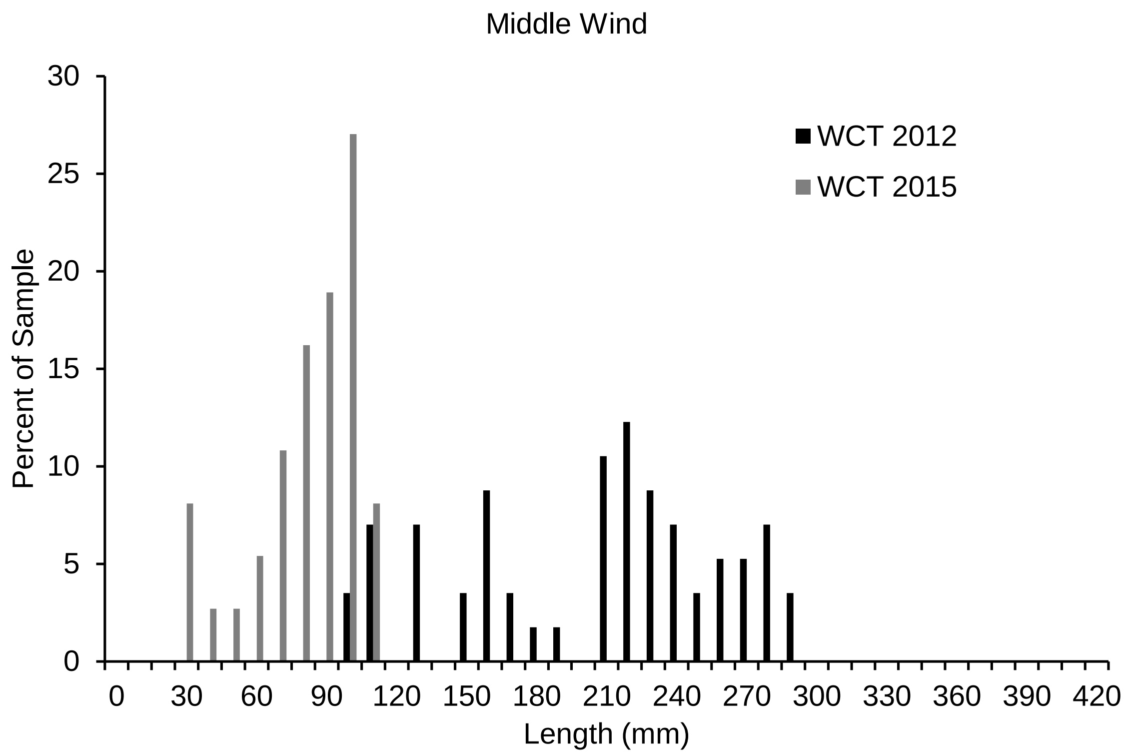


Figure 44 (continued)



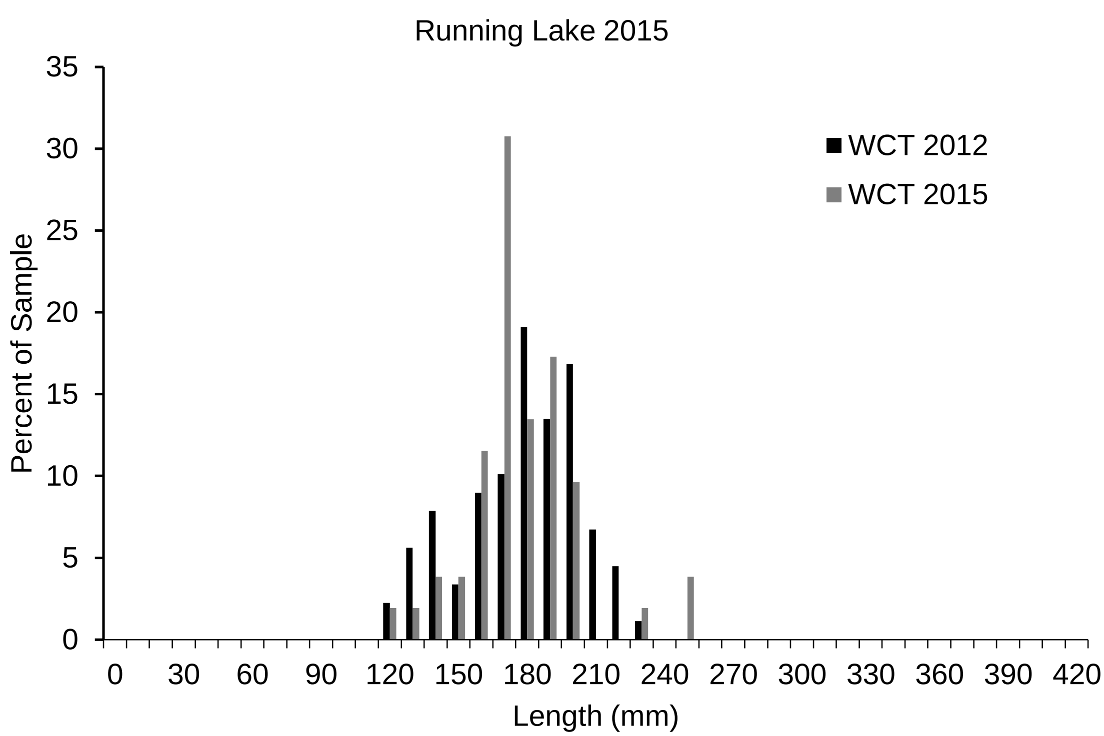
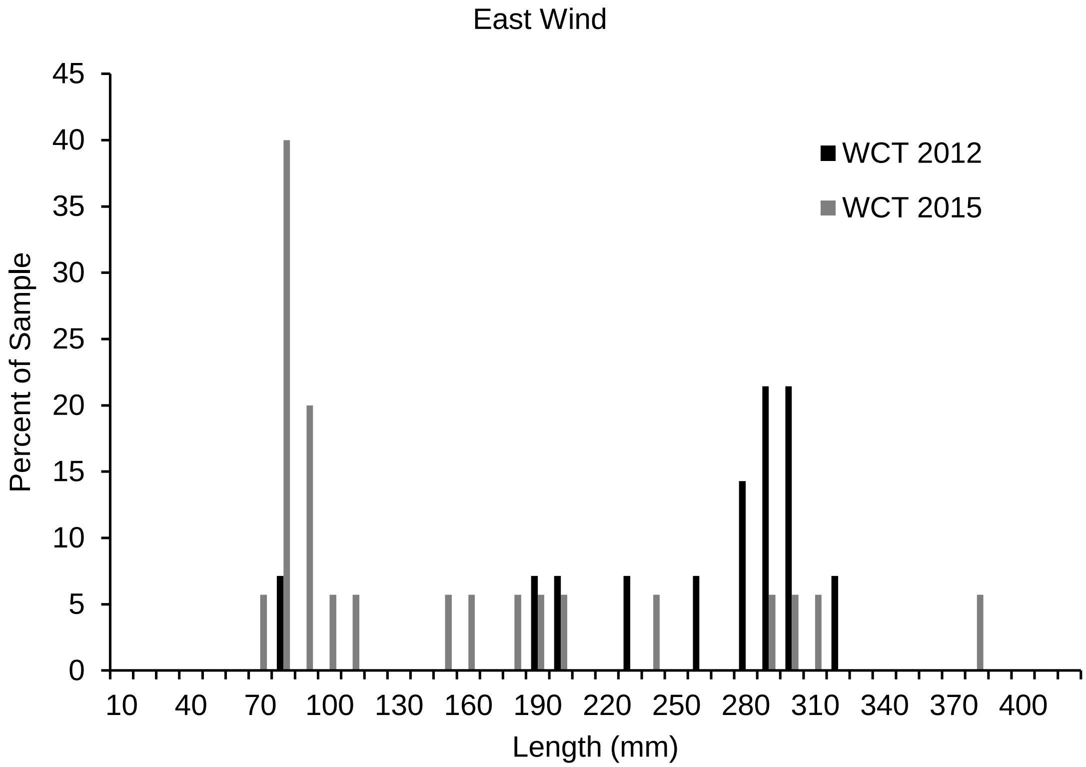


Figure 44 (continued)



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